POPULATION, FOOD AND THE FUTURE OF MAN 1/

Address by Lester R. Brown
Staff Economist, U.S. Department of Agriculture
at the Pacific Northwest Farm Forum
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The world today can be divided into two parts--the "haves" and the "have nots." The gap in living levels between these two groups is steadily widening. This widening gap is the most significant social, economic and political fact of our times.

Nowhere is this gap so noticeable as in the most basic of human needs--the need for food. Two thirds of the world's people live in countries where diets fail to meet the most basic nutritional needs. The number of people suffering from malnutrition is greater than it was a generation ago. Hunger today is commonplace throughout the less developed world.

This paper will discuss the food-population problem, its immediacy, its dimensions and our strategy to cope with it. Those of us who have thought of the food-population crisis as being in the future must re-adjust our thinking--it is here now.

1/ Much of the material in this paper is drawn from two earlier studies by the author. These are "Man, Land and Food" and "Increasing World Food Output." Both are available from the Office of Information, U. S. Department of Agriculture, Washington, D. C. 20250

Adjusting Food Population Imbalances: Past and Present

Throughout history adjustments of the imbalances between population and food have been frequent. The oldest kind of adjustment of course, is famine. Given the present state of technology and the values we attach to human life, this is no longer tolerable.

As the pressure of population on the land became unbearable during Europe's early development famine occurred from time to time, as in Ireland during the late 1840's, but emigration and trade were the principal means of maintaining a tolerable relationship between the number of people and the supply of food. Emigration to less densely populated areas of the world was the most important safety valve in the food-population balance. The New World today is largely populated by the overflow from Europe.

Historically Europe had a technological lead over most of the rest of the world. It was able to profitably export this technological lead in the form of manufactures, in exchange for the foodstuffs needed to feed its slowly but steadily growing population.

Other advanced countries outside Europe such as the United States, Canada, Australia, and New Zealand, were able to push back their frontiers throughout the early stages of development making more room for their growing populations.

For those countries now struggling to develop, these traditional means of alleviating population pressure no longer exist. There are not any significant possibilities for emigration in the world today. Nor do today's developing countries have a technological lead over the

rest of the world. In fact, they are confronted with a serious technological lag.

In today's developing countries, when the population becomes greater than that which the land can sustain and when export earnings are not adequate to cover food import needs, there are two alternatives: famine or obtaining food on concessional terms.

Since World War II, thanks to the productivity of our farmers, there has not been any largescale famine in the world, at least not in the Free World. The new safety valve in the food-population race is the U. S. Food for Peace Program. During the 10 years since Public Law 480, the enabling legislation for our Food for Peace Program, was passed we have shipped abroad 140 million tons of food.

Wheat has become our primary weapon in the worldwide war on hunger. Our 1964 wheat crop, exported largely during 1965, was consumed as follows:

Share of Crop	Where Consumed
2/5	United States
1/5	India
2/5	All other countries

Last Friday (February 4) the President announced that another 3 million tons of grain, consisting of 2 million tons of wheat and 1 million tons of grain sorghum, was being made available for immediate shipment to India. Without this massive shipment of grain, India would face famine within the near future. Never before in history has such a large share of the food-producing resources of one country been committed to the welfare of the people of another country as is now the case with the United States and India.

North America's Emergence as the World's Breadbasket

A generation ago, North America was 1 of 6 food exporting regions. It was not even the leading food exporter. Latin America, exporting 9 million tons of grain annually in the late 1930's was the leading food surplus region (See table below). North America was exporting 5 million tons per year--exactly the same as Eastern Europe (including the Soviet Union). Asia, Africa and Oceania (Australia and New Zealand) were also net food exporters. Western Europe was the only importing region.

Over the past 25 years, these food flows and the general trade pattern have been unrecognizably altered. North America and Oceania are the only consistent net exporters remaining.

World Trade by Major Geographic Regions 1/

Region	1934-38	1960	Expected 1966
	- - - Million metric tons - -		
North America	+5	+39	+60
Latin America	+9	0	+2
Western Europe	-24	-25	-23
Eastern Europe (incl. USSR)	+5	0	-14
Africa	+1	-2	-3
Asia	+2	-16	-30
Oceania (Australia & N.Z.)	+3	+6	+8

1/ Plus = net exports; minus = net imports. Minor imbalances between world imports and exports in a given year may be due to rounding or variations in reporting methods used by various countries.

Here is the story. Latin America plagued with a runaway population growth rate has lost its large export surplus and is today struggling to remain self sufficient. Eastern Europe has lost its 5 million ton

export surplus of the late 1930's. This year, according to preliminary estimates, it will be importing some 14 million tons. Both Asia and Africa are net food importers today. Oceania has upped its exports from 3 million tons prewar to an expected 8 million tons this year.

North America, exporting 5 million tons annually prewar is expected to export 60 million tons of grain this year. Roughly three fourths of this grain comes from the United States and one fourth from Canada. Even more impressive than the 60 million ton export level is the fact that North America could export 100 million tons of grain if the demand existed. If grain exports from North America continue to grow at the rate of the last few years, they will one day reach the 100 million ton level.

Our emergence as the world's breadbasket has occurred almost overnight, so quickly that neither we nor the rest of the world, have had time to assess its significance. This development testifies to the great strength of our agriculture, our economic system and, indeed, our entire way of life.

Underestimating the Food-Population Problem

There are two ways of increasing food production--expanding the area under cultivation and raising the yield per acre. Expanding the area under cultivation is not new. Man has been doing this even since agriculture began. Raising output per acre in a rapid sustained fashion, however, is a fairly recent phenomenon--an achievement confined largely to the more advanced countries.

Over the past quarter century all of the increases in food production in both North America and Western Europe have come from rising output per acre. The area under cultivation in both regions has actually declined. During this period, per acre yields in North America increased 109 percent and in Western Europe 37 percent. In the less developed world they increased 8 percent.

As the developed regions have exhausted the supply of new land that could readily be brought under cultivation, they have generated take-offs in yield per acre. Today's developing countries, faced with rapid rates of population growth, are running out of new land while still in the very early stages of economic development.

Generating a yield per acre take-off requires capital to purchase yield-raising inputs such as fertilizer, pesticides and improved seed. It requires a favorable relationship between prices for farm products and the cost of these yield-raising inputs. The nonagricultural sector must be capable of providing agriculture with the physical inputs mentioned above and all of the services, such as credit, transport and marketing, needed to support a yield take-off.

It is far easier to increase the food supply by expanding the area under cultivation than by raising output per acre. The failure to sufficiently appreciate the difference in these two methods and the difficulty in making the area-to-yield transition, particularly in underdeveloped economies, has resulted in a serious underestimation of the world's food problem.

Still another source of underestimation of the world food-population problem is the failure to distinguish between the potential for expanding food production rapidly and the prospects for doing so.

The potential for expanding food production is usually discussed in physical terms, i.e., that which is possible. Prospects, by contrast, are what is likely to be achieved--this is invariably far less than that which is technically or physically possible. Food shortages in the developing countries are due not to a lack of potential for increasing the food supply but to the inability to realize the existing potential as rapidly as current and projected rates of population growth require.

The Food-Population Equation Has Two Sides

Until quite recently, efforts to achieve a satisfactory balance between food and people were concentrated on the food side of the food-population equation. Belatedly we are beginning to realize that concentrating our efforts on the food side alone will not be sufficient.

To illustrate. Both Latin America and Western Europe have expanded food production at about 2.5 percent annually over the past decade. In Europe where population is increasing at about 1 percent per year this has meant progress and a steady upgrading of diets. But in Latin America where population has been multiplying at more than 3 percent per year, food output per person has declined.

Today's developing countries are faced with far higher population growth rates than those faced by the now-advanced countries at a comparable stage of development or, for that matter, at any time in their history. The sharp postwar spurt in rates of population increase in the developing countries has caused a whole host of new problems

including high dependency ratios and much greater demands for social services such as health and education.

Much of the aggregate progress achieved at such great cost to the developing countries is being eroded by runaway rates of population growth. These uncontrolled rates of population growth pose a more serious threat to nutritional and economic well-being than any other single factor.

Fortunately, we are beginning to realize the danger inherent in these explosive population growth rates. President Johnson, in his San Francisco address last June commemorating the twentieth anniversary of the United Nations, pointed out that 5 dollars invested in family planning achieves more progress than 100 dollars invested in other forms of economic development.

Man is the most intelligent species, the only species capable of voluntarily choosing between the quantity of life and the quality of life. The extent to which this choice is exercised over the next few years will strongly influence the history of the remaining one third of this century.

U. S. Food Producing Capacity and Projected World Food Needs

In 1960 the less developed regions of Asia, Africa and Latin America were consuming 470 million tons of grain. More than 450 million tons of this total was produced internally. By 1980, these regions will require, largely as a result of population growth, an estimated 770 million tons of grain or 300 million additional tons.

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This increase in food needs of 300 million tons is roughly the amount of grain produced today in North America and Western Europe combined. Stated otherwise, the less developed world must add to its current food producing capability the equivalent of that of North America and Western Europe. This will take a lot of doing!

The United States now produces about 175 million tons of grain annually. We could increase our output by some 50 million tons of grain if we brought the acreage now diverted to conservation uses under our farm programs, back into use. If most of the land now idle were used to produce feedgrains, the additional production would be considerably greater than 50 million tons; used mostly for wheat, it would produce somewhat less than 50 million tons.

This 50 million or so tons of excess capacity seems large when considered in terms of excess stocks. It does not seem nearly as large when related to the projected increase in food needs of the developed regions. Over the next 10-15 years, projected increases in domestic grain requirements and commercial export demand will largely offset projected gains in agricultural productivity, leaving the excess productive capacity--that available for food aid--at about 50 million tons.

When our excess capacity is related to the future gains in food needs in the less developed regions, it is clear that most of the additional food needs of these regions must be met through the expansion of their own food production. President Johnson recognized this basic fact in his Foreign Aid Message to Congress a week ago today. "We

cannot meet the world food needs of the future, however willing we are to share our abundance. Nor would it serve the common interest if we could."

Our Strategy in the War on Hunger

Our strategy in the war on hunger is dictated by certain basic facts and trends. The excess food producing capacity of the United States represents the only major reserve of food in the world that can readily be called forth in the race between food and people. Other major grain producing countries such as Canada, Australia and the Soviet Union do not have large areas of fertile, well-watered land that can readily be put into production. The Soviet Union may, in fact, be forced to abandon some of the marginal land brought into grain production a few years ago. Western Europe, already heavily dependent on imported foodstuffs, cannot provide food to meet the growing food shortages in the developing countries.

The gap between food needs and food production in the less developed world is widening rapidly. A generation ago the less developed regions of Asia, Africa and Latin America were net grain exporters, shipping 11 million tons of grain annually to the developed regions, principally Western Europe. During the War decade of the 1940's this flow was reversed. Grain moved from the developed world to the less developed world at the rate of 4 million tons per year in the late 1940's. During the 1950's this increased to 13 million tons per year. By 1964, the last year for which complete data are available, it had reached 25 million tons. We do not know exactly what the flow

will be in 1966 but it is certain to be at least several million tons greater.

Over the span of one generation the total change in net trade--from exports of 11 million tons to imports of 25 million tons--totalled 36 million tons. Even more significant, however, is the fact that the massive food imports have not been adequate. Food prices have risen sharply in several less developed countries over the past few years. The gap between food needs and food production is widening even more rapidly than the import figures indicate.

Another key fact influencing our strategy is that the adverse food-population trends are pervasive and they have a great deal of momentum. Arresting and reversing these trends will not be easy. The large group of females who will be in the reproductive age group in the early 1980's are already born. Significant reductions in birth rates are not expected soon. Modernizing agriculture is a slow and time consuming operation. The food gap is certain to become much larger before it begins to get smaller.

We must use all the resources at our disposal to reverse these unfavorable trends while there is still time. To fail to do so while gradually using up our excess food producing capacity would result in unspeakable tragedy for there is no other major safety factor in the food-population race.

In summary, our war on hunger is being waged on three fronts today. We are shipping food to the food deficit countries, buying time for them to modernize their agriculture we are helping aid-recipient countries improve their own agriculture by providing technical assistance

and modern inputs such as fertilizer; and we are helping with family planning programs.

If you will permit me to use an alliterative device, we can refer to this as the food, fertilizer and family planning approach. The prospects of winning the food-population race are greatly enhanced by the decision to move in all three of these areas.

Nonconventional Sources of Food

Thus far we have determined that food needs in the developing countries will increase very rapidly over the next few decades. And thus far our discussion has centered about conventional agriculture. But what about nonconventional sources of food such as algae from the sea, petrochemicals or deserts irrigated with desalted sea water?

Looking to the sea as a source of food to support the world's ever-growing population is not a new idea. It has been discussed at least since the time of Jules Verne and possibly long before that. The fact remains, however, that man is still dependent on conventional agriculture for 99 percent of his food energy. Fish and other products from the ocean supply only 1 percent.

Contrary to popular opinion, the oceans do not contain unlimited quantities of fish. Countries with large fishing fleets, such as Japan Norway, the Soviet Union, and the United States, compete vigorously in the best fishing areas. Considerable concern exists in some areas over tendency to "over fish."

The possibility of producing algae for food is often mentioned. Although technically possible, a marketable foodstuff with wide appeal has yet to be developed.

It is now possible to synthesize food from basic raw materials, such as petroleum. But the large-scale production of synthetic

foodstuffs that are nutritious, palatable, and economically competitive with the products of conventional agriculture, does not offer a near-term solution to the food problem.

The use of desalted sea water to make the deserts productive offers a third nonconventional solution to the food problem. It is now technically possible to remove the salt from sea water so that it can be used for irrigation purposes. One day it may be possible to irrigate some of the world's vast deserts, such as the Sahara in North Africa and the vast arid interior of Australia. But despite the progress made in reducing the cost of desalting sea water and in lowering the cost of atomic power, it will probably be close to a generation before large-scale commercial cultivation of the deserts is possible. As of now, it appears that man will continue to look to conventional agriculture for the bulk of his additional food needs for many years to come.

The Next Fifteen Years

The world must make room for a billion people to be added to the world's population over the next 15 years. This fact in itself is significant. But even more significant, fully four fifths of this total will be added in the food-short, less developed regions--regions where the fertility of the people is already outstripping the fertility of the soil.

The modernization of agriculture in the developing countries means altering the basic behavior patterns of nearly half of the world's people.

Time, or the lack of it, is the critical new dimension in the world food-population equation. Runaway population growth rates in countries with little new land to bring under cultivation requires rapid changes in methods of food production. Changes taking centuries in the developing countries must be compressed into decades. Those requiring decades must be compressed into years.

The situation is not hopeless. Some developing countries report promising progress in efforts to both modernize agriculture and slow down population growth rates. Taiwan, Israel and Mexico have achieved impressive gains in food production. Both Taiwan and South Korea are, through nationwide family planning programs, beginning to reduce their population growth rates. These countries, however, are conspicuous because of their success. And among the scores of developing countries they are few.

The momentum of trends now in existence ensures that the gap between food production and food needs in the less developed world will widen further. Some countries will likely face acute food shortages between now and the time when these trends are reversed. We must be prepared to respond.

Conclusions

1. The unfavorable trends in per capita food production and food imports in less developed countries are too pervasive, their implications too serious, to be taken lightly.

2. Uncontrolled population growth in the less-developed countries poses a more serious threat to nutritional well-being and to ultimate economic viability than any other single factor.

3. Although nonconventional sources of food are often discussed, it appears likely that man will continue to rely upon conventional agriculture for the bulk of his food supply for the forseeable future.

4. Winning the worldwide war on hunger requires that the war be waged on three fronts. We must continue to ship food to the food deficit countries, buying time with which they can modernize their agriculture; we must assist and encourage the food deficit countries to accelerate their agricultural development efforts; we must help the developing countries with family planning programs, bringing their population growth rates down to manageable levels.

5. North American food and food producing know-how may be the decisive factors in the worldwide race between food and people.

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THE WORLD FOOD/POPULATION PROBLEM: AN OVERVIEW

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Two months ago we began the last third of the Twentieth Century, a period promising to be one of the most difficult man has yet experienced. If the most recent population projections materialize, the history of this period may be influenced more by the explosion in the number of people than any other single factor.

We are focusing here on the problem of food shortages in the less developed countries but this shortage like the shortage of classrooms, of housing, and jobs is a symptom of a much more basic problem -- uncontrolled rates of human increase. The world is now adding a million more people each week -- most of them in the less developed countries. This flood of people is washing away the benefits of millions of man-years of effort and billions of dollars in foreign aid.

The problem is so basic that man is baffled and bewildered, unable to cope with the human tidal wave. India, whose population passed the 500 million mark this past summer, is finding it impossible to meet the basic needs of her people. The current Five Year Plan, spanning the period from 1966 to 1971, allots only 1 dollar per year to educate each child of elementary school age.

Remarks by Lester R. Brown, formerly a member of the U.S. Department of Agriculture Staff Economists Group and designated Acting Administrator of the Department's International Agricultural Development Service, at the Conference on "Alternatives for balancing future world food production and needs," sponsored by Iowa State University, Center for Agricultural and Economic Adjustment, Ames, Iowa, November 8, 1966.

A decade ago most of the less developed countries were making encouraging advances in per capita food production. Since then population growth has gained momentum and many of the encouraging advances have become discouraging declines.

Only five years ago the United Nations coined the years 1960 to 1970 the Decade of Development. If the adverse food/population trends of the first half of this decade are not reversed, it may well be recorded as the Decade of Disappointment.

Latin American agriculture has performed well over the past decade, increasing food production two and one-half percent per year, matching the performance of Western Europe. In Western Europe, where population gains at one percent per year, this is progress; but in Latin America, where it increases three percent per year, this outstanding performance is inadequate.

World food production this year is exactly the same as last year. But there are 65 million more mouths to feed. It is not surprising then that our stocks of food are shrinking.

A decade ago our costly and burdensome surpluses were a favorite subject of editorial writers. Today those surpluses are gone. There are no surpluses of wheat, rice, feedgrains, soybeans, dairy products, or any other major commodity in this country or anywhere else in the world. Though burdensome, these surpluses gave us a sense of security -- a sense of security we no longer have.

Two Simultaneous Explosions

There are now two explosive forces generating additional demand for food. One is the population explosion. Much has been said and written about it.

This is illustrated by the now familiar curve of world population growth in figure 1.

The second explosive force is the rapid rise in per capita income occurring in many countries, particularly the more advanced ones. Much less has been said about the income explosion than about the population explosion. The food problem has been characterized as a race between food and people. In fact, it is a race between world food demand and production.

Both the population explosion and the income explosion are fairly recent phenomena confined largely to the post war period. Prior to World War II neither population or income had increased very rapidly anywhere in the world. Population growth rates were still below one percent per year and income levels for much of the world were still at the subsistence level; even in the more advanced countries annual incomes were still only a few hundred dollars.

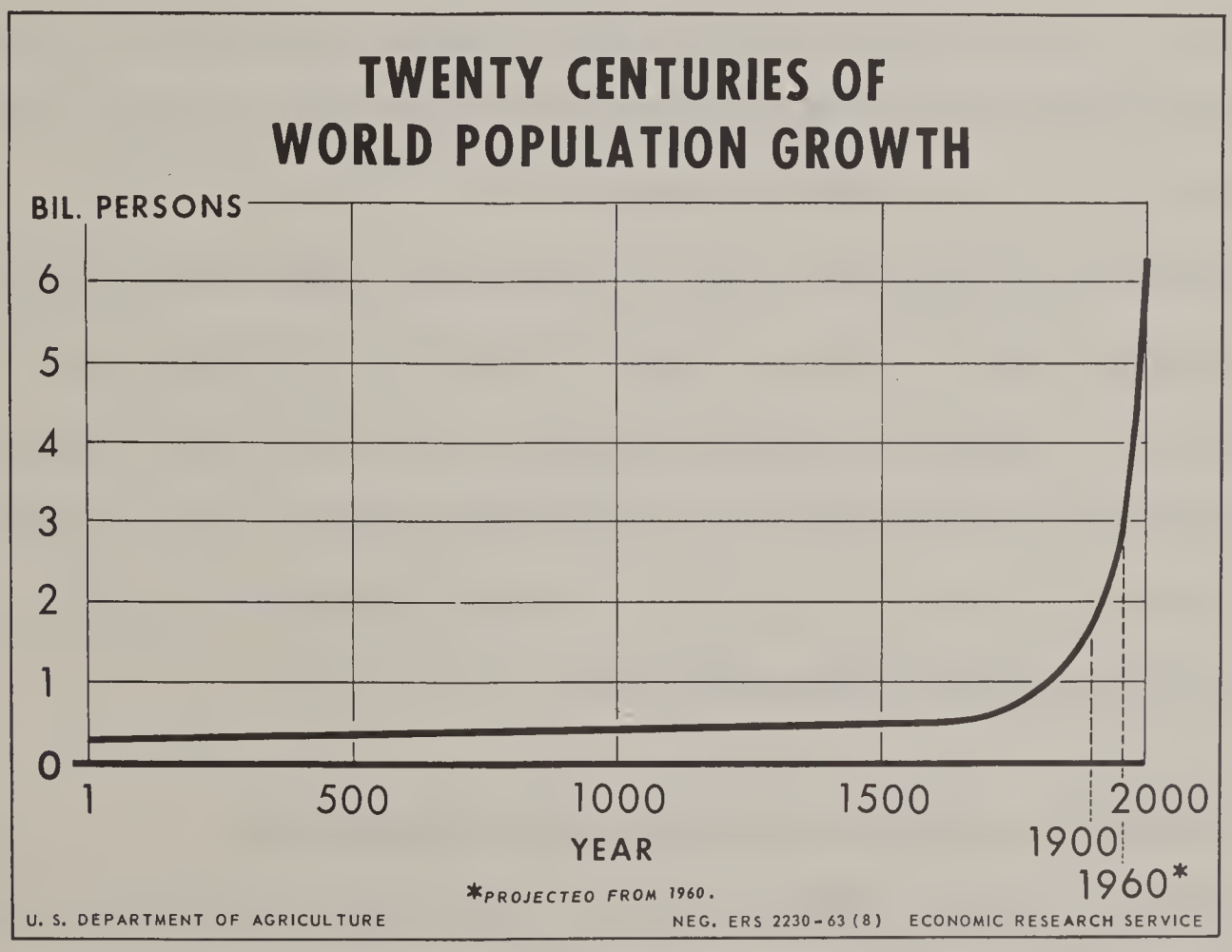

Figure 1

Population Explosion

Less developed countries today are, almost by definition, countries with rapid rates of population growth. This phenomenon, aptly termed the "population explosion," is so recent that we have not yet had time to assess its impact. Populations growing three percent per year double within a generation, and multiply 18-fold within a century. To an agriculturist this demographic arithmetic is frightening.

In response to this deluge of people, we are beginning to shift our thinking, our planning, and our resource allocation from the earlier objective of improving diets to that of avoiding famine.

This year nearly one-fourth of our wheat crop will be shipped to India. Moving this vast quantity of grain is requiring 600 ships -- the largest peacetime armada ever assembled, and possibly the largest assemblage of ships since D-Day. No one knows how much will be needed next year but significantly, this vast movement of U.S. food, this year supporting 60 million Indians, is not achieving any improvement in diets.

To those of us who work in agriculture it is clear that an acceptable balance between food and people cannot be achieved by focusing our attention on food alone. President Johnson recognized this in his San Francisco message commemorating the 20th Anniversary of the United Nations when he said: "Let us act on the fact that less than five dollars invested in population control is worth $100 invested in economic growth."

Income Explosion -- Higher Per Capita Grain Requirements

Enough for the population explosion. Too little attention is given the income explosion which is also expanding the worldwide demand for food.

The use of all grain considered aggregately as a yardstick, provides a means for measuring food needs and for translating these food needs into resource requirements. Grains occupy more than seventy percent of the world's cropland. In terms of calories they provide more than half of man's total food energy when consumed directly, and a sizable part of the remainder when consumed indirectly in the form of meat, milk and eggs. Within the less developed countries the direct consumption of grains provides two-thirds of the total food supply. Thus, grain can be used to measure the increase in food needs associated with either population growth or rising incomes.

The difference in the amount of resources required to provide the high quality diets prevailing in North America and those prevailing in the less developed world is much greater than generally recognized. In caloric terms the range goes from something like 2,000 calories per person per day in the less developed world to something over 3,000 calories per day in the United States -- a difference of about fifty percent. But this difference measures only quantity. It does not measure the quality of diet.

Some 1,600 pounds of grain per person per year are required to provide the high protein diet common to the United States. This contrasts sharply with the annual availability of 400 pounds per person in the less developed countries. The difference is not fifty percent, as indicated by the caloric intake levels, but a difference of four-fold.

The desire for more animal protein in the diet seems to be common to all societies. It is apparently an inherent physiological characteristic of man. The level of income appears, not surprisingly, to be the only important factor constraining the level of animal protein intake. Stated otherwise, animal protein consumption rises as rapidly as incomes and purchasing power permit. (Figure 2)

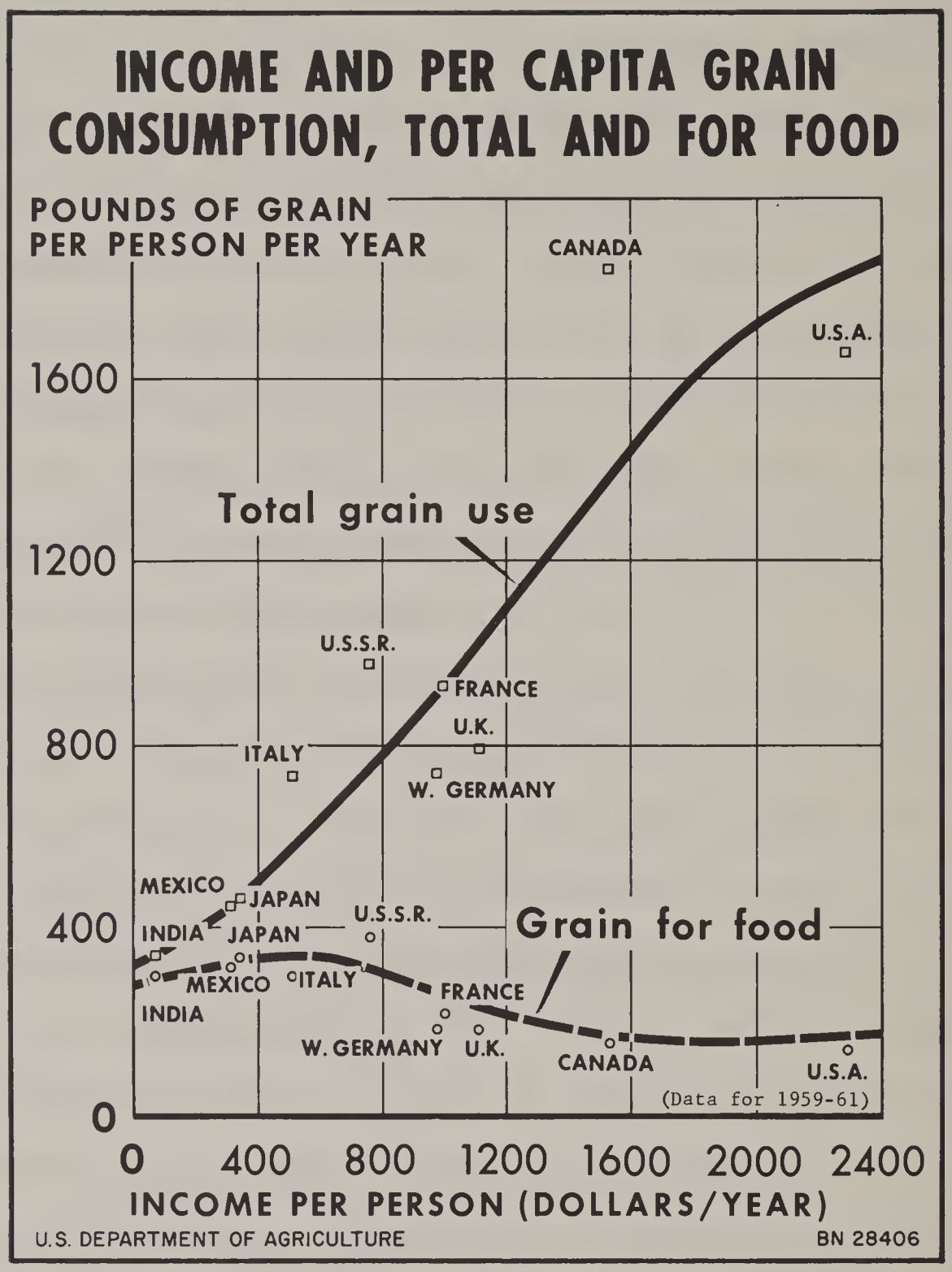

Figure 2

In the early stages of development, when annual grain availability is only 400 pounds per person, nearly all must be consumed directly to maintain life, at the subsistence level. Of this amount, some ten percent must be used for seed, leaving only about 360 pounds, or one pound per day for human consumption. (Figure 3)

Table 1.--Average annual income per person and grain used per person, for food and in total, 1959-61

Country	Annual income per person	Grain used per person per year	
		Food	In total
	Dollars	Pounds	Pounds
Canada	1,532	152	1,848
United States	2,288	157	1,654
Mexico	312	315	445
France	1,003	219	928
Germany, West	982	181	739
Italy	511	298	732
United Kingdom	1,111	181	792
Soviet Union	762	377	979
India	68	298	340
Japan	346	337	463

Source: Food Balances for 1959-61 prepared by Foreign Regional Analysis Division, Economic Research Service, U. S. Department of Agriculture.

Rising incomes exert pressure on the world's food producing resources not only because they generate an additional demand for meat and other animal products but also because as incomes rise the share of grain-fed meat, particularly beef, often increases while the share of grass-fed beef declines. In Canada for instance, the share of grain-fed beef has increased from twenty-four percent to fifty-four percent since 1951. A similar shift seems to be occurring in some of the more advanced countries of Western Europe.

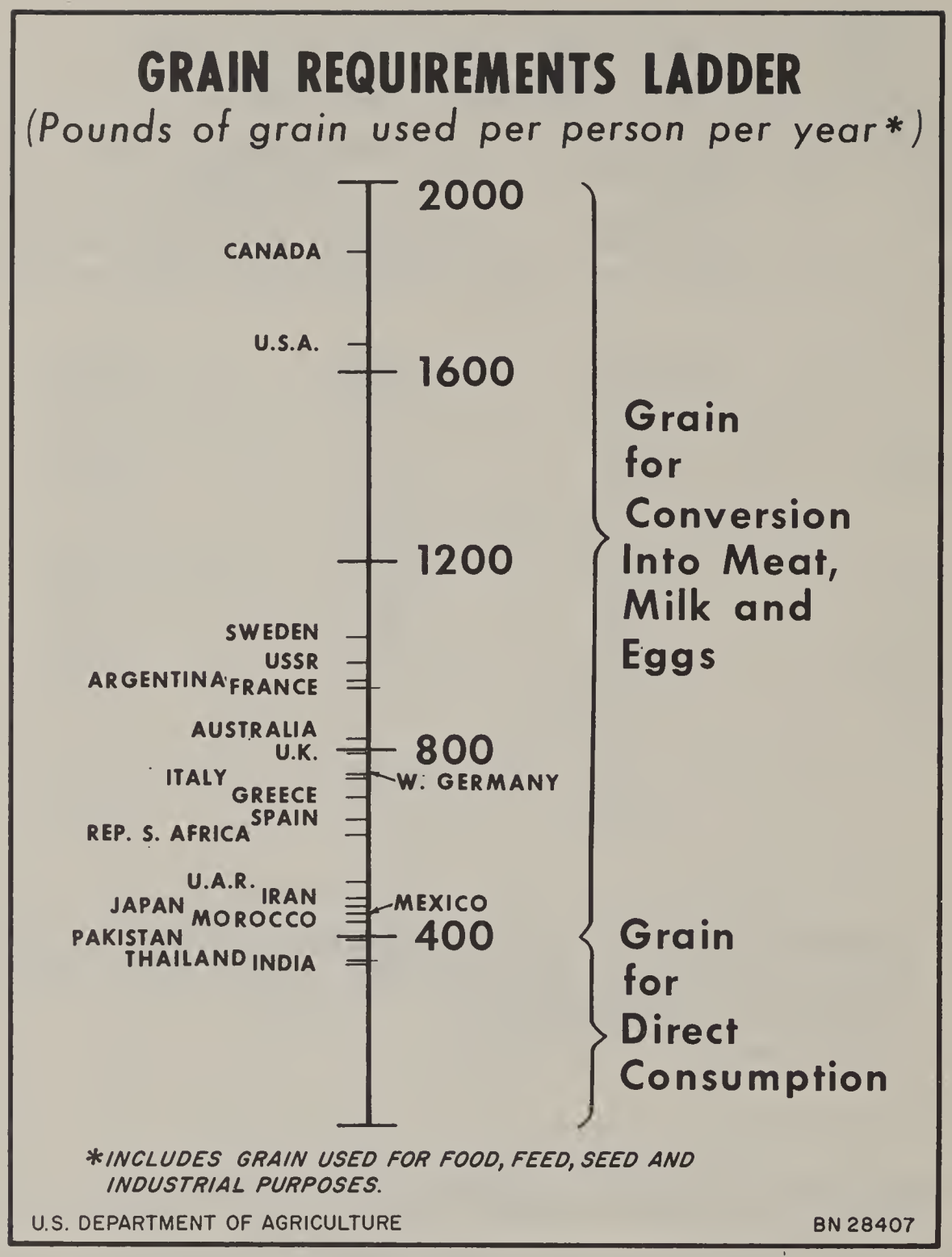

Figure 3

The use of grain for direct consumption never seems to exceed 400 pounds per person per year regardless of the level of income. Once annual incomes reach several hundred dollars per year, the consumption of grain as food begins to decline, dropping to the 150-200 pound level where it seemingly levels off.

The upper curve in figure 2 indicates that annual grain consumption per person, both direct (as in bread) and indirect (as in meat, milk and eggs) rises about one pound for every two dollar gain in annual per capita income. This explains why grain requirements are rising so rapidly in countries such as Japan, where per capita incomes are increasing 7 percent yearly, and West Germany, France and Italy where they are increasing 4 to 5 percent yearly.

The countries in figure 2 were selected to cover the entire spectrum of income levels and to encompass as large a share of the world's population as possible. Only the larger countries in each geographic region were included. Mainland China was omitted because of a lack of data. The ten countries included in figure 2 have 1.3 billion people or one half of total world population, excluding China.

Sharp population increases, occurring mostly in the world's less developed regions, are reflected in the fast-growing demand for foodgrains. Increased per capita incomes, now the stated objective of every country, developed or less developed, are reflected in the rising demand for feedgrains. Together, these two explosions occurring at the same time, are causing an explosion in demand which the world's farmers are not able to match.

A Reassessment of Trends

It was not too long ago that we were saying that we had 15 or 20 years to solve the world food problem. But it now appears that we have much less time in which to stop and reverse the unfavorable food/population trends outside the United States.

Projections of world food production and demand over the past several years have had two things in common, regardless of where they were done or by whom. Almost without exception they underestimated the rate of increase in

food demand, and overestimated the rate of increase in food production in the less developed countries.

Stocks Down, Consumption Up

Many of the difficulties associated with making accurate projections trace to the use of incomplete and shaky data on both food production and food consumption. In some countries projections of food production are based on multi-year production plans which are invariably overly optimistic.

An analysis of the trends in world stocks of grain -- held almost entirely by the major exporters of wheat, feedgrains, and rice -- show the emergence of some new and disturbing trends. During the eight years from 1953-1961, world grain stocks increased each year, averaging 9 million tons per year. (Figure 4) During this period world production was running ahead of consumption. (Figure 5)

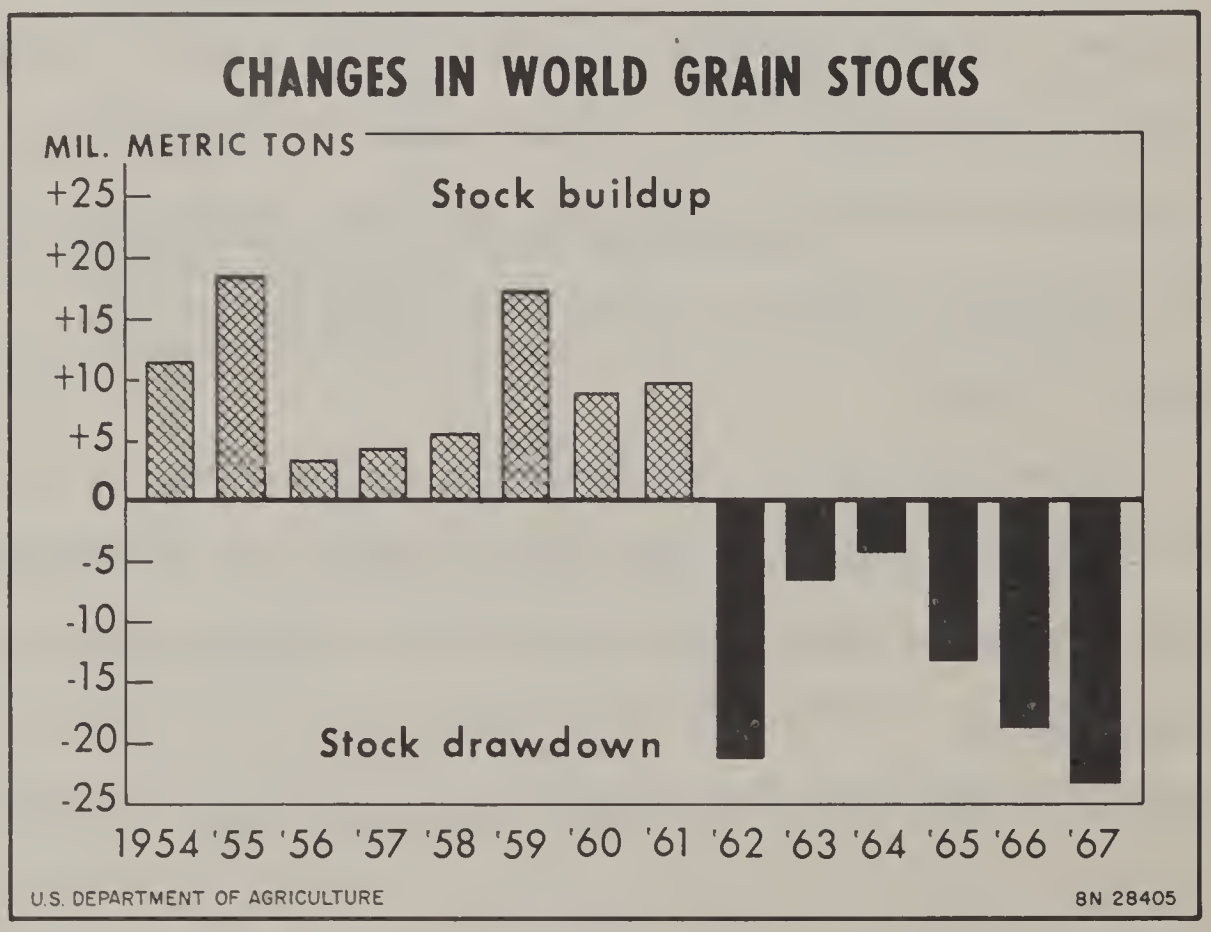

Figure 4

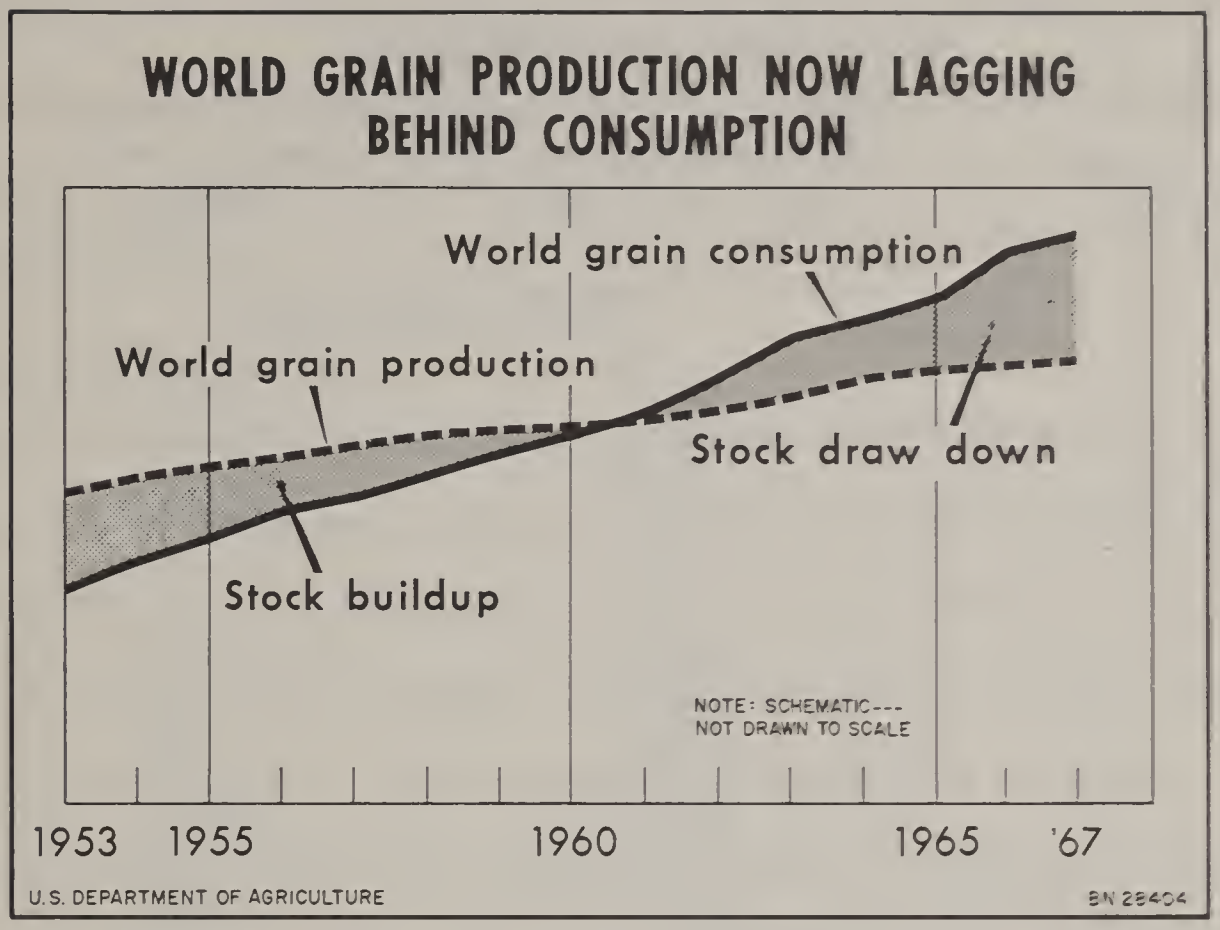

Figure 5

During the six years from 1961 until 1967, world stocks of grain have declined each year. In the early 1960's this was due in part to an increase in the acreage of cropland idled under farm programs in the United States. The average rate of decline during this period was 14 million tons per year. A stock drawdown of this size, with world production about a billion tons a year, means that since 1961, world grain consumption has been exceeding production by 1.4 percent a year.

This excess of consumption over production was satisfied by using the excess stocks held by the major exporting countries, particularly the United States. With these stocks now about gone, efforts are being made to offset the excess of consumption over production by bringing back into production idled cropland in the United States. Once this is used up then it will be much more difficult to cope with the growing gap between consumption and production.

Table 2.-- Carryover Stocks of Grain in Major Exporting Countries 1/

Year	End-of-year carryover, all grains	Year-to-year change
	Million Metric Tons	
1953	57.2	--
1954	68.5	+ 11.3
1955	86.9	+ 18.4
1956	90.4	+ 3.5
1957	94.9	+ 4.5
1958	100.2	+ 5.3
1959	117.3	+ 17.1
1960	126.2	+ 8.9
1961	136.0	+ 9.8
1962	115.0	- 21.0
1963	108.8	- 6.2
1964	104.8	- 4.0
1965	91.9	- 12.9
1966	73.5	- 18.4
1967 2/	50.5	- 23.0

1/ Since importing countries do not have the capacity to carry grain stocks of any size, changes in stocks of exporting countries are assumed to represent changes in worldwide stock levels.

2/ Preliminary.

Using Idled Cropland

As recently as 1965, 56 million acres of U.S. cropland were idled. Decisions taken in recent months to expand the acreage allotment for wheat (an additional 17 million acres) and feedgrains (12-15 million acres) combined with a need for several million more acres of soybeans this coming year will bring from one-half to two-thirds of this remaining reserve back into production.

How will the world offset this excess of consumption over production, if it continues, once the ready reserves of stored grain and idled cropland are used up? This is the question the world must confront and answer in the next few years.

Symptoms of Food Shortages

There are many who feel that the coming food crisis will be ushered in by something very dramatic, such as a headline in the morning newspaper reporting several million dead from starvation in some distant country. I don't believe it will be that obvious. Rather, there will be many symptoms of an unfolding food crisis. Some of these are already in evidence.

Almost every major less developed country -- whether it be India, Pakistan, Indonesia, the UAR, or Brazil -- has experienced rising food prices in recent years. Rising prices are causing inflation and forcing a reduction in development expenditures and the overall rate of economic growth. In these countries, the effective demand for food is outrunning the available supply, even with sharply larger imports.

As food prices rise, upper and middle-income groups increase their expenditures for food, largely offsetting the rise in prices. But the low-income groups, who may already be using four-fifths of their limited income to buy their food, can't increase their expenditures enough to offset the price rise. They must buy less and tighten their belts.

This is not consistent with the rise in expectations characterizing nearly all the world's people today. The result is demonstrations, riots and, in some cases, revolution.

Over the past several months the price of rice moving in international trade has risen sharply. A ton of rice now costs twice as much as a ton of wheat, even though the nutritional content is little different. The more advanced countries still buy about as much rice as before, but the less developed countries with limited foreign exchange earnings must reduce imports.

The world's wheat reserve is much smaller now than a few years ago. As wheat supplies tighten, again it is the less developed countries which reduce imports most. As these countries are forced to cut food imports, the gap between the "haves" and the "have nots" grows wider. This, I would submit, is not a healthy state of affairs for either group. Economic and political stability depend more on an adequate supply of food than any other single factor.

Several months ago Secretary of Defense, Robert McNamara, gave a speech in Montreal in which he pointed out that over the past eight years serious outbreaks of violence have occurred more in the poorer nations than the middle-income or high-income countries.

> Since 1958, only one of these 27 [rich] nations has suffered a major internal upheaval on its own territory. Among the 38 very poor nations -- those with a per capita income of under $100 a year -- not less than 32 have suffered significant conflicts. Indeed, they have suffered an average of two major outbreaks of violence per country in the 8-year period. That is a great deal of conflict. What is worse, it has been predominantly conflict of a prolonged nature. There is an irrefutable relationship between violence and economic backwardness. And the trend of such violence is up, not down.

We also know now that a lack of proper food in the early stages of life may stunt not only physical growth but mental development as well. The malnourished child of 1966 is the underdeveloped adult of 1986. Malnutrition is, by a wide margin, the world's number one health problem.

We need not wait for a newspaper headline describing a massive famine, although that conceivably might come if the world does not move quickly to mobilize the necessary resources. Summing up, the symptoms of food shortages are rising food prices, less food for the poor in the low income countries, economic instability, political instability, and violence.

The reason for growing food shortages can be simply stated. There is little new land that can be readily brought under the plow and many of the less developed countries are not able to raise yield per acre in a rapid sustained fashion.

Limited World Possibilities of Expanding Farmland

Anyone who looks at a world map with the cultivated areas marked cannot fail to be impressed with how little of the earth's land surface is used to produce food. This has led many to assume that there are vast areas of the world ready and waiting to be brought under the plow. But such is not the case.

Estimates of how much new land can be brought under cultivation vary widely. These estimates have little meaning, however, unless they specify at what cost the additional acreage can be made productive.

Over the past 30 years it has been more economic in North America and Western Europe to expand food production by raising output per acre than by increasing the area under cultivation. Production in both regions has doubled in a generation while the area under cultivation in both regions has actually declined.

Our own experience in the dust bowl years of the 1930's pointed out clearly the dangers of over expansion in marginal rainfall areas. The Soviet

Union failed to benefit from our experience and in the late 1950's, under Khrushchev, began plowing the semi-arid virgin grasslands of central Russia. The Russians too, are learning of the dangers of over expansion as they abandon sizable areas which simply do not receive enough rainfall to sustain cultivation year after year.

Turkey had a similar experience in a period of enthusiastic expansion during the early 1950's. Much of the grassland plowed for grain has now returned to grass.

Land hunger is common to a great majority of the world's less developed countries. There is little new land that can readily be brought under cultivation in Asia, the Middle East and North Africa. The tropical rain forests of Sub-Sahara Africa and Latin America offer a possibility for substantial expansion of cropland, if we can learn how to manage these soils, sustaining their fertility once the lush natural vegetation is removed.

Another possibility for expanding the world's cultivated area will come when the desalting of seawater becomes efficient enough to permit irrigation of some of the world's major deserts. But this is probably a generation away.

Raising Output Per Acre

Most of the increases in food required to meet the projected increases in demand over the remainder of this century must come from raising productivity of land already under cultivation. This is the most significant single fact to be considered in seeking a solution to the world's food/population problem.

Achieving this increase in land productivity requires several critical changes. Capital inputs and technology must be used on a massive scale,

substituting for the new land no longer available. Getting farmers to use modern inputs requires a food price policy ensuring a favorable relationship between the price of farm products and the cost of purchased inputs such as fertilizer.

Foreign private investment in agricultural supply industries is often required to provide the fertilizer, pesticides, improved seeds, farm implements and other modern inputs on the scale needed. On July 21, Secretary Freeman, addressing a meeting of the 20-nation Organization for Economic Cooperation and Development, described this need and our response:

> In response to the growing need for agricultural inputs, we are making available sharply increased quantities of these items under our aid program.... Over the longer term the aid-recipient countries must develop their own agricultural supplier industries. To fail to do so will simply result in a shifting of dependence on aid in the form of food to aid in the form of agricultural inputs, creating an impossible burden for the advanced countries. We must assist the developing countries in creating the investment climate needed to attract capital and the accompanying managerial, technical and marketing know-how.

Some Encouraging Developments

In spite of the discouraging trends in food production and population growth, there are some encouraging developments on both these fronts. Perhaps the most encouraging development to date is the growing recognition of the problem. This is an essential first step. Recognizing that the food/population equation has two sides is also essential to solving the problem.

With the fertility of the people outrunning the fertility of soil in country after country this recognition did not come too soon. A major technological advance, the development of a successful intrauterine contraceptive device, or IUD as it is commonly called by family planning officials, has raised hopes everywhere. It provides a means of limiting

family size which is both less expensive and much more simple than most of the traditional means. Using this, plus an assortment of more traditional approaches to family planning, has permitted both South Korea and Taiwan to appreciably reduce birth rates over the past three years.

India too is developing a nationwide family planning program in which the IUD figures prominently. The target of one million IUD insertions for the year ending last June 30 was significantly surpassed. An additional four million insertions are planned for this year. Whether or not this target will be reached remains to be seen, but the encouraging fact is that with the IUD India has made more progress in family planning in the past year than in the preceding decade.

It will be many years before even a majority of the estimated 50 million mothers in India now eligible for family planning will be reached but at least there is a realistic expectation that the population tide can be stemmed. With India's population now over the 500 million mark, and increasing at the rate of 14 million people per year, this did not come too soon.

Some of the newly developed countries have already benefitted from the results of intensive agricultural development programs. Israel, Taiwan, and Mexico, have achieved impressive advances in crop output in recent years.

Japan is assuming a leadership in Asian agricultural development, including their "farmers in residence" program in India, which places a Japanese farm family in an Indian village, to demonstrate improved methods.

The U.S. aid program to Taiwan is now being phased out, and Taiwan is carrying out its own technical assistance program in Vietnam, and several African countries.

An agricultural diversification program in Thailand has doubled exports within the past decade.

These are only a few examples. Though isolated, they indicate that success in agricultural development is possible, under the right conditions.

Finally, research holds great hopes for improving the world food situation. The Rockefeller Foundation working in the Philippines, is making impressive progress in developing new, more productive varieties of rice. The next, and perhaps most difficult step is to adapt these varieties to local growing conditions throughout the rice belt of Asia.

More research, especially adaptive research, within and by the less developed countries is a key factor in solving the world food problem. Until now most of the more spectacular research successes in the less developed countries, particularly in plant improvement, are attributable to the private U.S. foundations; but they cannot do the entire job. Our aid programs must include the building up and staffing of effective experiment stations and research centers in the less developed countries, along with training programs to increase the number of effective agricultural scientists, again in the less developed countries.

But transforming research results into reality is often far more difficult than perfecting the test tube success. Food shortages are not due to a lack of potential for expanding world food production but to the inability to realize the potential quickly enough.

Conclusions

Food shortages will continue over the years ahead as the population juggernaut continues to gain momentum in the less developed world and as

incomes continue the rapid rise of recent years in the more advanced countries. Forces and trends now in existence will tend to aggravate the imbalance between food and people in the "have" and "have not" regions of the world. The next 15 years may be the most difficult ones. During this period we can expect to add another billion people. Significantly, we have never added a billion people before in such a short time. Even more worrisome, fully four-fifths of the billion will be added in the less developed countries where food is already in chronic short supply.

Achieving the satisfactory balance between food and people will require dramatic increases in farm productivity in Asia, Africa and Latin America, comprising half the world's population. The transition from traditional to modern agriculture, which must be achieved within the next decade and a half, will require more change in human behavior, in a shorter time, than has ever before been achieved.

Governments of the less developed countries must make some difficult political decisions. Food price policies must become producer-oriented rather than consumer-oriented; farmers must be assured of a price for their products which will make the use of fertilizer and other modern inputs profitable. In order to provide their farmers with massive injections of capital inputs and new technology, governments of the less developed countries must create a climate for foreign private investment far better than exists in most countries today.

Governments in the less developed countries must allocate much more resources to family planning. No area of endeavor today is so urgent or so neglected. Many countries are still thinking in terms of pilot projects and research, but the time for this has passed.

Eradicating hunger in a world with an exploding population is one of the most complex tasks man has ever set for himself. Putting a man on the moon is simple by comparison. It is an engineering problem. A difficult engineering problem. But it is an engineering problem, involving relatively few skilled people.

Eradicating hunger in the less developed regions means raising the productivity of the rural people of Asia, Africa and Latin America -- half the world's population. This in turn requires changing the basic behavior patterns of these people. Seldom has history required that so much change be compressed into so short a period of time. The transition from traditional agriculture to modern agriculture must be made quickly, telescoping the transition which required centuries in the western world into decades and years.

Time is the critical new dimension in the world food problem. The strategy for relating our food and food producing know-how to the world's needs is simple. We plan to continue to ship food abroad under concessional terms, buying time with which the developing countries can slow down population growth and accelerate food production.

To date, most aid recipient countries have not used this time wisely. Under the new food aid legislation, however, they must do so in order to maintain their eligibility for food aid.

NARROWING THE FOOD GAP

The food production gap between the "have and "have not" countries has widened steadily in recent years. This widening is due not so much to differences in overall rates of increase in food production between these two major economic groupings as to dramatic differences in rates of population growth.

Despite these many adverse trends there are nevertheless some recent encouraging developments which enhance the prospect of accelerating food production in the "have not" countries within the next few years. A more rapid expansion of food production will help buy time in which to bring the rate of population growth to a manageable level. Indeed, one of the leading challenges before us and the world today is to see how quickly the food gap can be narrowed.

The Historical Record: A Widening Gap

The historical record of food production, trade and price trends in the less developed world over the past quarter century is not a happy one. Continuing gains in per capita food output in the economically advanced countries contrasts sharply with that of the less developed world where per capita food output has been lower throughout the 1960's than it was during the late 1950's. (See Figure 1.) Much of the decline since the late 1950's traces to the poor performance of agriculture in Mainland China. Of course, there is little that we can do to help this situation.

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Talk by Lester R. Brown, Administrator, International Agricultural Development Service, U. S. Department of Agriculture, at the Massachusetts Institute of Technology Single-Cell Protein Conference, October 9, 1967.

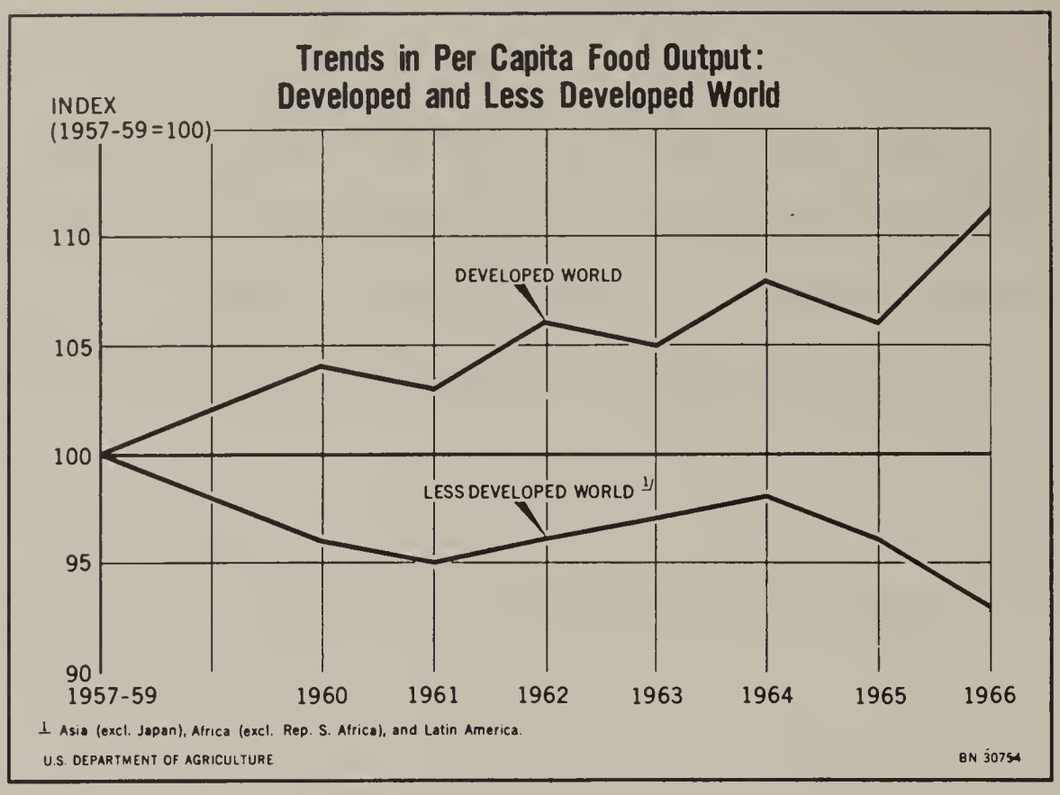


Figure 1

But the unusually sharp decline of the past two years is attributable in large measure to the two consecutive monsoon failures experienced on the Indian subcontinent. However, this trend should be sharply reversed this year as the cumulative policy reforms and technological gains of recent years, obscured by the two monsoon failures, combine with the current exceptionally favorable monsoon to produce a bumper crop. At this reading, a month before harvest begins, it appears likely that the Indian foodgrains crop will exceed the record 1964/65 harvest of 89 million tons by as much as 5 million tons. Pakistan, too, appears to be headed for an excellent harvest.

Lagging per capita food output in the "have not" regions is reflected in both growing imports and rising internal prices of foodgrains. The pattern of world grain trade has been dramatically altered in recent years, again largely because of unprecedented population growth rates in the developing countries.

The Food Flow Reverses

Thirty years ago each of the less developed regions -- Asia, Africa and Latin America -- was a net grain exporter, exporting largely to Western Europe. (Figure 2.) The net outflow of grain from the less developed regions averaged 11 million tons yearly. Latin America exported more grain than North America.

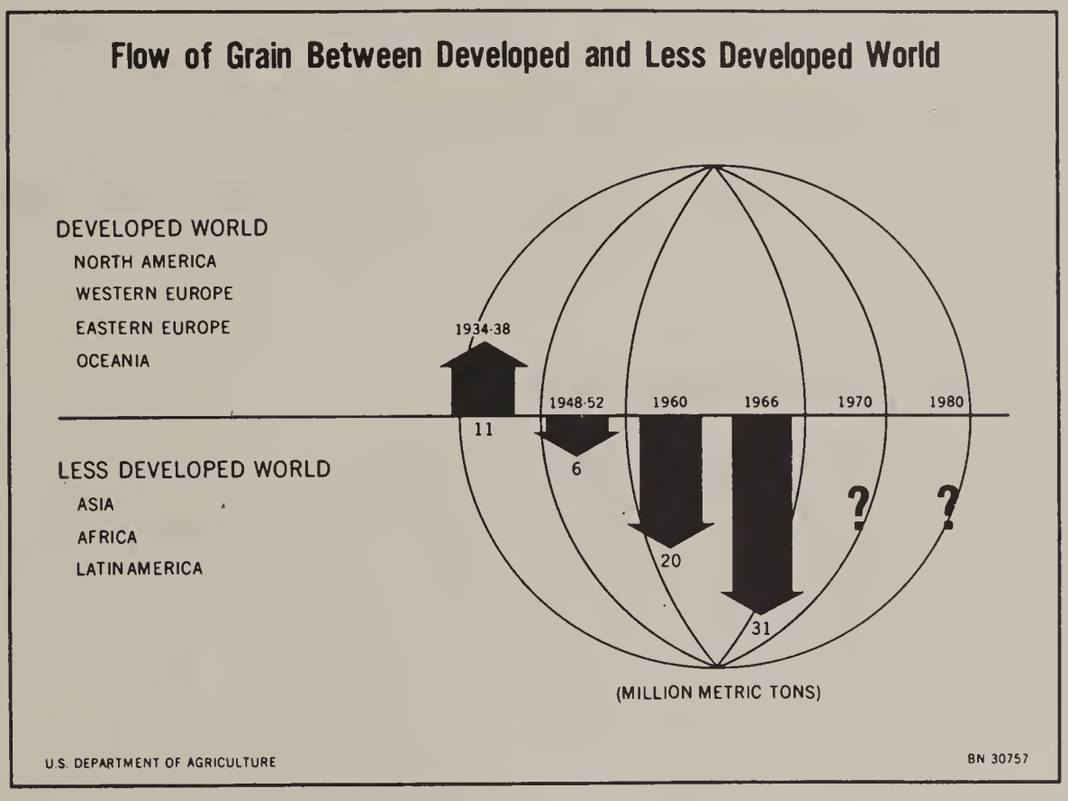


Figure 2

During the war decade of the 1940's this net flow of food was reversed and food began to flow from the "haves" to the "have nots". Grain, traditionally a source of export earnings for the less developed world, now required foreign exchange outlays to finance imports. By 1950 grain was flowing from the "have" to the "have not"

regions at the rate of 6 million tons yearly. As the population explosion gained momentum during the 1950's this flow of grain into the less developed regions steadily accelerated, reaching 20 million tons by 1960; by 1966 it had climbed further to 31 million tons. The six most populous countries, Mainland China, India, Indonesia, Pakistan, Japan and Brazil, were all net grain importers.

The key question in viewing this persistent, historical trend and the future is, how much net grain imports will be needed in 1970? In 1980? Can the recent trend be arrested and reversed in the foreseeable future?

The Wheat-Rice Price Differential Widens

Rice is the principal food staple for most of the people living in the low income regions of the world; wheat is the principal staple in the advanced industrial countries. World rice prices, rising slowly since 1960, have moved up sharply over the past two years. (Figure 3.) Much of the Asian rice moving in world trade in recent months has sold for more than $200 per ton. Wheat prices, by contrast, have been remarkably steady over the past decade, with leading quotations averaging about $75 per ton. At current world market prices, one ton of rice can be exchanged for about 2.7 tons of wheat in the world grain market. This wide difference exists in spite of the fact that nutritionally the two commodities are quite similar.

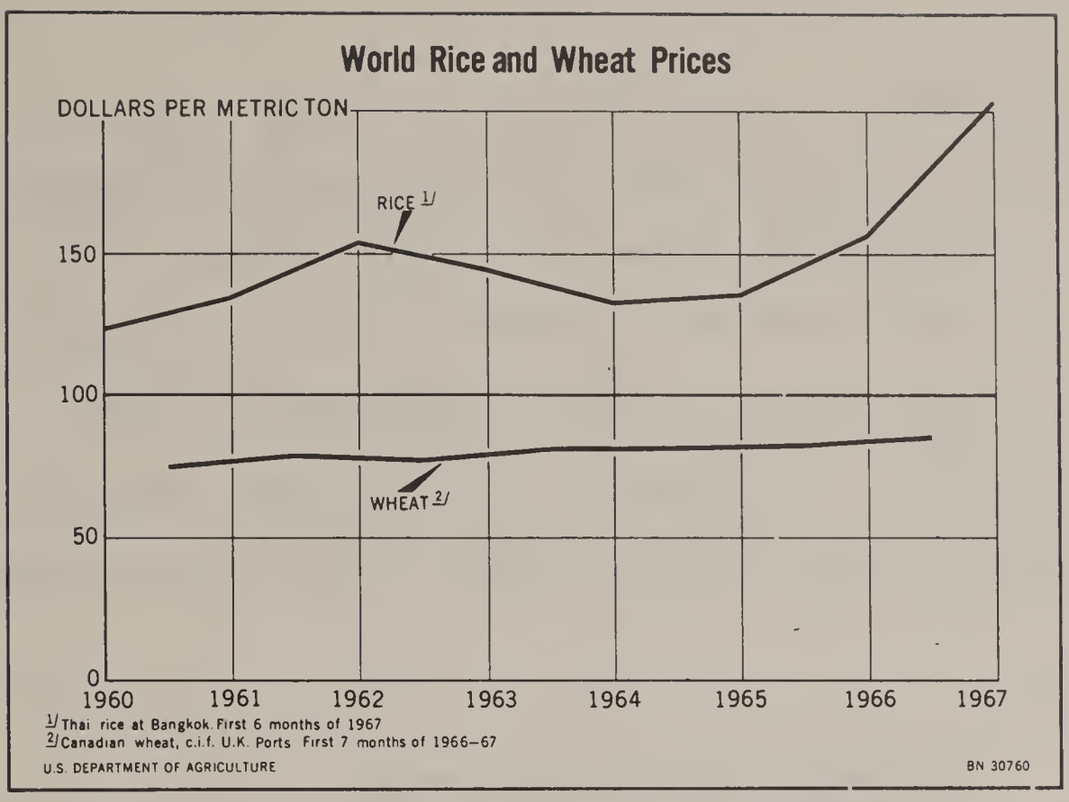


Figure 3

Although many factors contribute to this growing shortage of rice, two are dominant. On the demand side, all of the world's rice consuming populations, with the significant exception of Japan, are continuing to multiply rapidly. On the supply side, the area of land suitable for producing rice is rather rigidly defined by topography, temperature, soil types, and water availability. Most increases in production must come from raising per acre yields, something many less developed countries are not well prepared to do.

World production of wheat can be expanded much more rapidly in response to need than can rice. As wheat supplies tightened in late 1965 and 1966, the United States responded by bringing into production a large share of its idle land; a similar excess capacity does not exist within the world's major rice producing regions.

Why The Widening Gap?

The single most important factor contributing to the reversed flow of food described above is the accelerated population growth rates common to nearly every less developed country. At present, the population growth rate of the less developed world is double those of the developed world (Figure 4.) The old adage "the rich get richer and the poor get children" describes well the two economic groups.

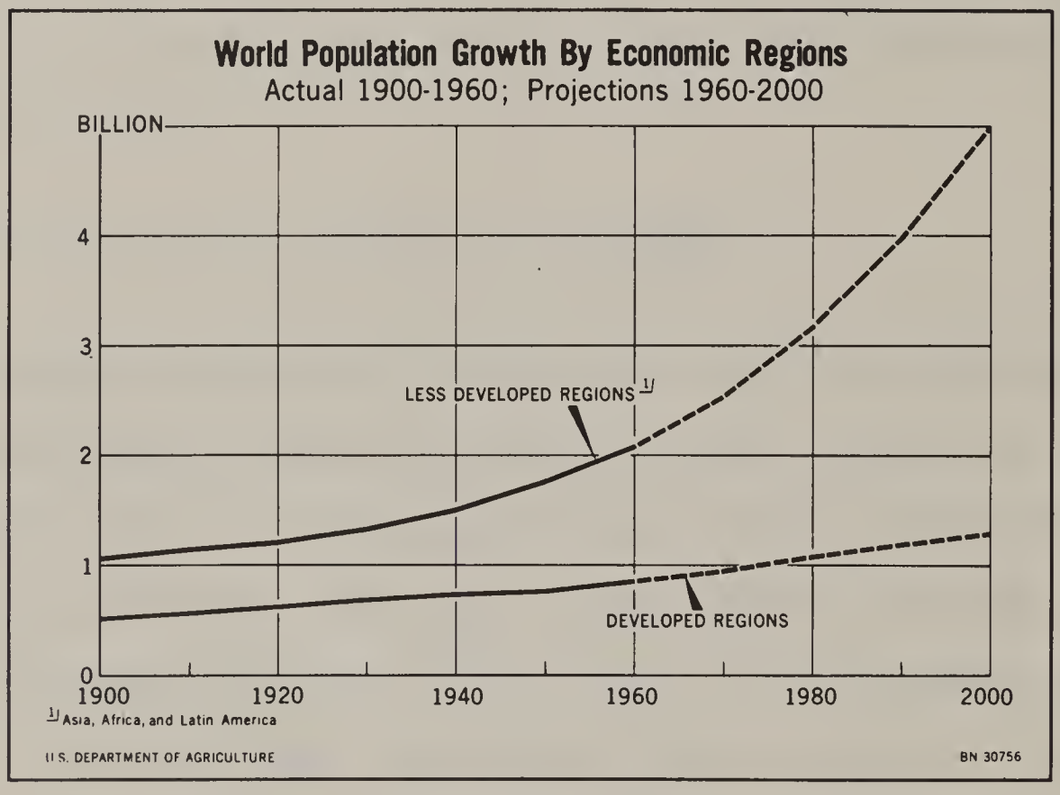


Figure 4

The addition of a billion people over the past one quarter century has been a traumatic experience for the developing countries. This deluge of people has resulted not only in food shortages, but has also

upset development plans, canceling the benefits of billions of dollars worth of foreign aid. What will be the effect of adding a projected 2 billion or more people in the less developed world over the next 3 decades?

Should this projected population increase materialize, it is quite certain to widen further the gap between the "haves" and "have nots". This is the most significant economic, social and political fact that our generation and the one to follow must confront.

Implications of the Widening Gap

Thus far during the 1960's the rate of gain in per capita income in the rich countries, averaging some two percent yearly, has been double that of the poor countries. Both overall income levels and food output levels in the rich and poor countries are becoming more disparate.

Political Implications

The food gap is widening both absolutely and relatively. A world in which one-third of us worry about our waistlines while the other two-thirds worry about where their next meal is coming from is not a pleasant one. Nor in the long run will it be a peaceful one.

In the summer of 1966 Secretary of Defense McNamara spoke in Montreal pointing out that over the past eight years serious outbreaks of violence have been concentrated in the poor or low-income countries.

> "Since 1958, only one of these 27 (rich) nations has suffered a major internal upheaval on its own territory. Among the 38 very poor nations -- those with a per capita income of under $100 a year -- not less than 32 have suffered significant conflicts. Indeed, they have suffered an average of two major outbreaks of violence per country in the 8-year period. That is a great deal of conflict. What is worse, it has been predominantly conflict of a prolonged nature. There is an irrefutable relationship between violence and economic backwardness. And the trend of such violence is up, not down."

The trend Secretary McNamara outlined continues unabated today. During the year since he gave his speech we have seen Nigeria, Africa's largest country, become involved in a long drawn-out civil war. Several Middle Eastern countries including Israel, a relatively advanced country, were involved in a brief but costly war, which set back development efforts by at least a few years. Bolivia is beset by insurgency. The conflict in Vietnam countinues. China, the largest country in Asia, seems on the brink of civil war. The Chinese and Indians have clashed in Sikkim. Interestingly, these conflicts are confined almost entirely to the less developed, less fortunate countries.

We need not look to the less developed countries to see what happens when a people's expectations for a better life significantly exceeds actual improvements in living standards. We need only look to Newark, Watts, and Detroit.

Economic Implications

The failure of farm production to move ahead at a satisfactory rate in the developing countries has disturbing economic implications. The transition of the less developed world from a net grain exporter to a net grain importer has contributed to the adverse balance of payments of many developing countries.

The failure of agriculture, which comprises half the national output in many less developed countries, to advance at a sufficient rate has significantly reduced overall rates of growth, not only because of agriculture's failure to contribute its share, but also because of the effect a poorly performing farm sector has on the level of economic activity in the remainder of the economy.

Those less developed countries which have attained target rates of economic growth during the 1960's are so few that they are the exception rather than the rule. And the dominant factor contributing to this poor performance has been seriously lagging farm sectors.

An even more disturbing implication of food shortages traces to some of the longer term human costs, as yet uncalculated. Recent medical evidence indicates that serious protein shortages in the early years of life reduce not only the lifelong potential for physical development, as we have long known, but also the potential for mental development. Unfortunately, this damage occurring in the early years of life is irreversible.

A first step in assessing the cost of malnutrition, disease, and illiteracy for a developing country is given in Figure 5.

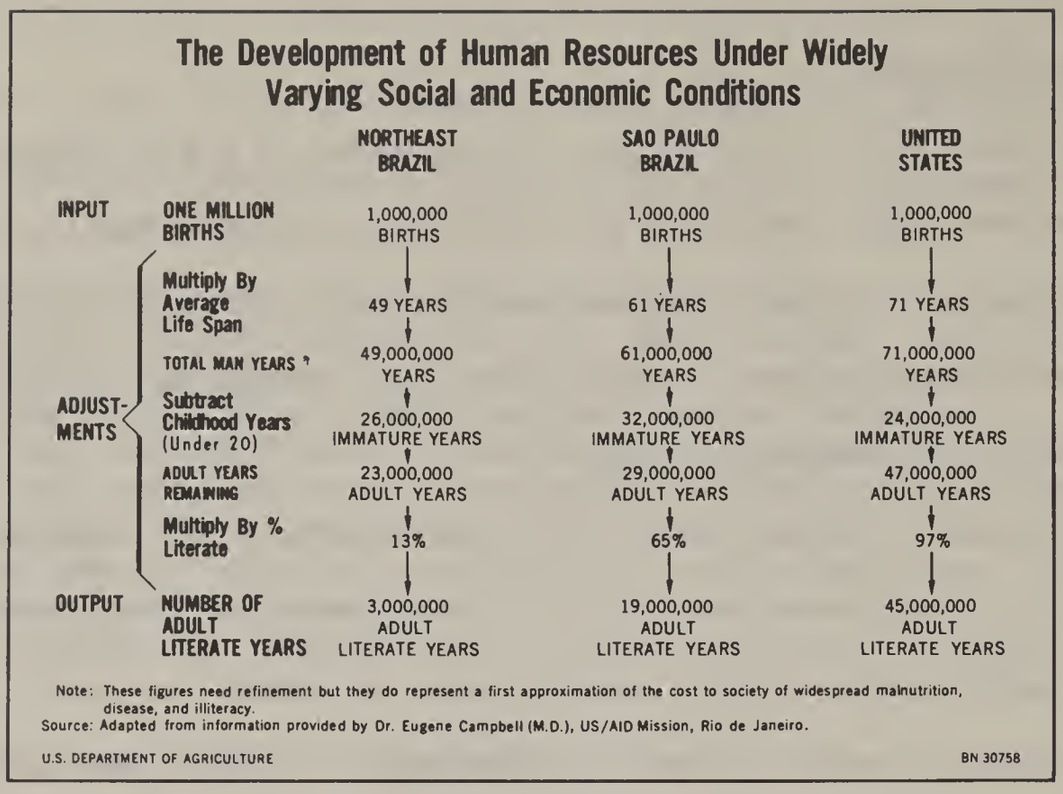


Figure 5

Dr. Eugene Campbell of the USAID Mission in Rio de Janeiro, very much concerned about this problem in Brazil, has made an attempt to estimate this cost by contrasting the potential contribution to society of a million people born in Northeastern Brazil; Sao Paulo, Brazil; and the United States. After reducing the potential contribution by adjusting for the incidence of malnutrition and disease, as reflected in life expectancy and illiteracy, he concludes that the final contribution to society measured in terms of adult literate man years varies from 3 million in Northeastern Brazil to 45 million in the United States.

Encouraging Prospects for Narrowing the Gap

Food production can be expanded either by expanding the area in production or by raising yields. Throughout most of history, increases in food production have come largely from expanding the cultivated area. It is now becoming far more costly to engage in this geographic expansion. As a result, since about 1950 some 70 percent of the worldwide increases in production have resulted from rising yields. (Figure 6.) In fact, all of the increases in food production in both North America and Western Europe over the past quarter century have come from raising per acre yields; the area under cultivation in both regions has actually declined during this period.

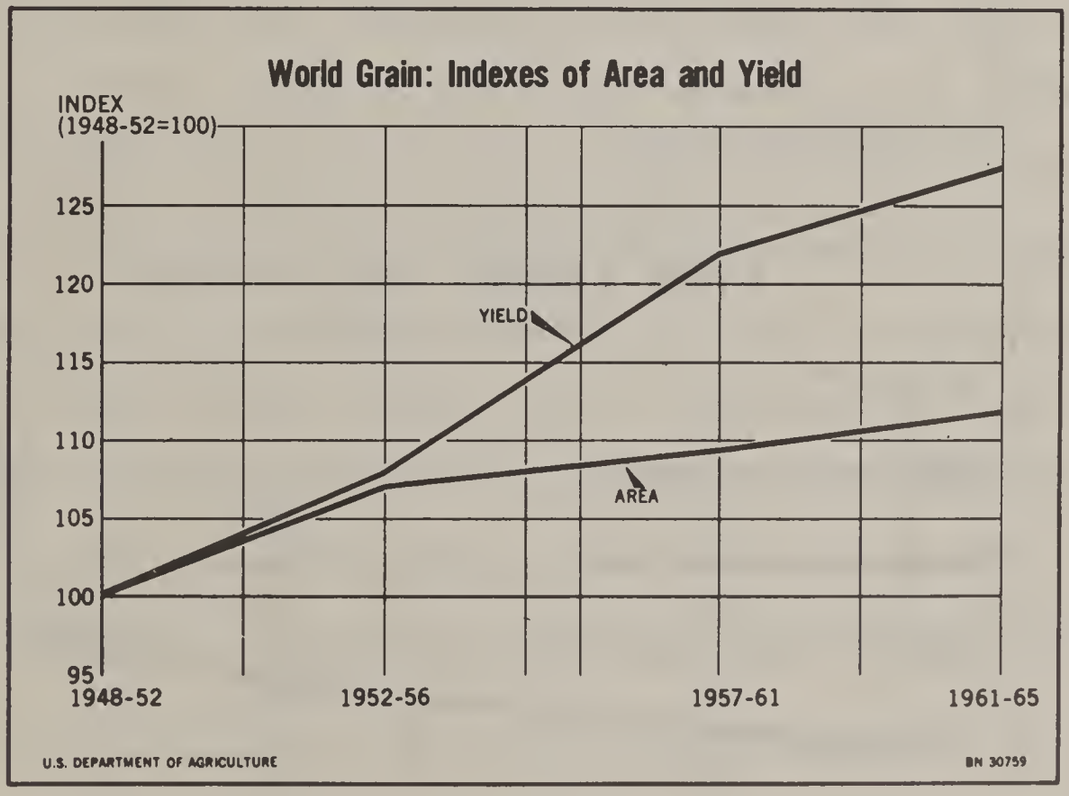


Figure 6

Many of the less developed countries, having exhausted the supply of new land that can readily be brought under the plow, must now generate yield per acre takeoffs similar to those which occurred in North America, Western Europe and Japan. (See Figures 7 and 8.)

Figure 7

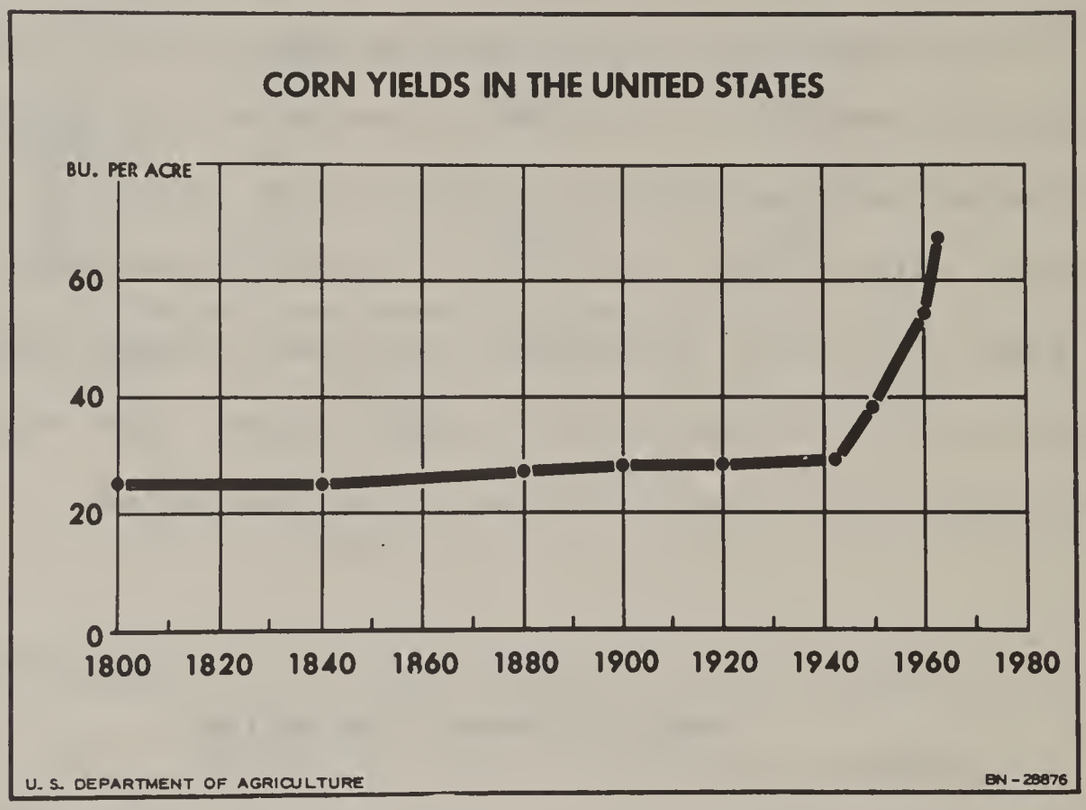
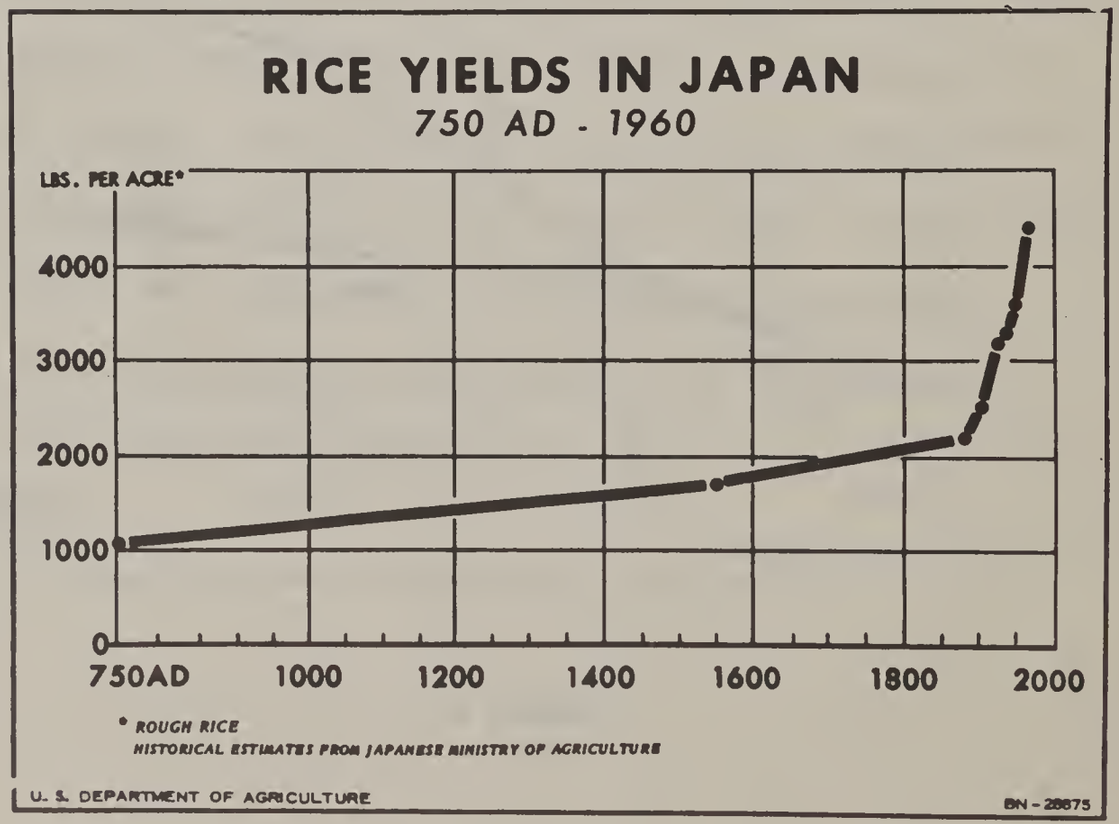


Figure 8



A continuing trend of static yields would be disastrous. Fortunately, there is growing evidence that the long awaited yield takeoffs may be about to occur in some of the major developing countries.

The New Emphasis on Agriculture

Agriculture, long neglected by many developing countries, is now beginning to receive a degree of attention more nearly commensurate with its importance. In large measure this is due to a shift in United States food aid policy which is also related to the disappearance of surplus stocks of rice and wheat in 1965 and 1966. Food aid is no longer free. It is made available only to those countries making an honest effort to expand their own food production. To be eligible for food aid, countries must commit themselves to take specific actions to improve agriculture. Commodities are exchanged for commitments. These commitments, varying widely between countries, may include such things as the construction of farm-to-market roads, the construction of a fertilizer plant, or the expansion of farm credit systems.

This tighter leash on United States food aid is beginning to show results. Agriculture is now being placed at the top of the list of priorities in many less developed countries. Budget allocations to agriculture are increasing sharply. Fertilizer supplies have been doubled or tripled in a score of countries within the past few years.

New Varieties, New Hope

Until quite recently, the prospects were not good for rapidly increasing cereal production in developing countries. Traditional varieties were genetically capable of only a limited response to modern inputs. Heavy applications of fertilizer applied to weak stemmed, traditional varieties sometimes caused widespread lodging and loss of crop, with an actual reduction in overall yields.

Within the past few years, however, the groundwork has been laid for a major advance. Exciting, new varieties of both rice and wheat, capable of doubling or tripling yields under optimum conditions, are being tested in many developing countries. Mexican dwarf wheat varieties, proving highly adaptable under widely varying conditions, are being widely grown in India, Afghanistan, Pakistan, and Turkey. Rice varieties developed at the International Rice Research Institute in the Philippines, though not quite so far along, are nevertheless proving equally exciting in the tropical and sub-tropical rice producing countries.

Rice and wheat are man's principal food staples, each supplying about one-fifth of his total food energy supply. With the recent varietal breakthroughs described above the possibilities of meeting the projected increases in food needs in the less developed world are brightening.

Advances in Fertilizer Technology

Rapid progress is being made in reducing the cost of synthetic ammonia used in nitrogenous fertilizers. The "second generation" ammonia plants now beginning to come onstream will reduce substantially the cost of fertilizer to farmers, providing a strong incentive for greater use.

Of course, the prices of food staples in the developing countries must make the use of fertilizer profitable. Under price levels prevailing until recently, this was not the case. This has now changed in countries such as India and Pakistan. Food prices there have risen to such an extent that the demand for fertilizer has expanded rapidly, often far exceeding the available supply. (See Figure 9.) Hopefully, this favorable fertilizer/foodgrain price ratio will continue.

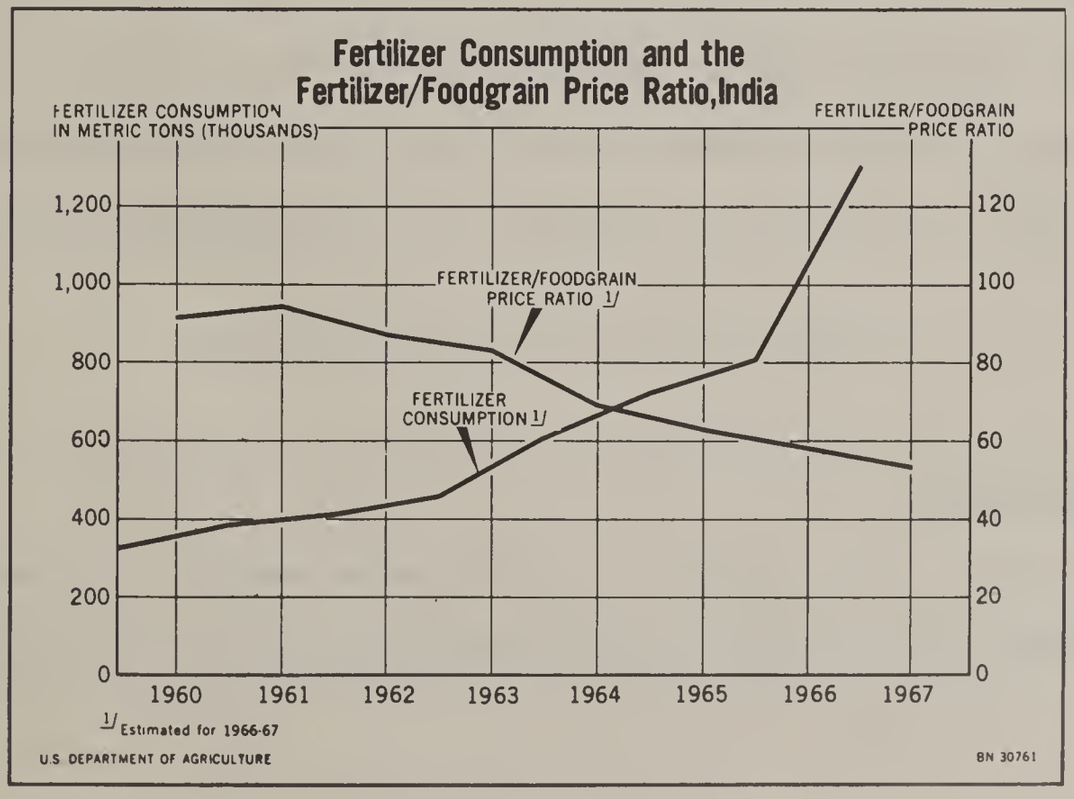


Figure 9

Advances in Food Technology

Attention to technological advances bearing on the world food situation focuses heavily on production technology. Not to be overlooked, however, are some recent gains in techniques of food fortification.

Fortifying foods with vitamins and minerals to improve their nutritive value is not new. This is now standard procedure in all advanced industrial countries. What is new is the prospect of fortifying foods with synthetic amino acids. A few dollars worth of lysine -- the amino acid in short supply in wheat protein -- added to a ton of wheat raises the quality of wheat protein to more nearly that of casein. Although it is among the less conventional approaches to reducing the protein deficit, it is in the short run one of the most promising. Unlike many other methods of upgrading protein intake, the addition of amino acids to conventional foodstuffs does not require any changes in dietary habits or consumption patterns.

Because of the large potential payoff in this area, the fortification of wheat with lysine is currently a priority activity of the Department.

A New Food Industry

To reiterate, the food problem is, in large measure, a protein problem. There are available in almost every less developed country

sizable quantities of high quality protein. These indigenous protein supplies, principally cottonseed, peanut, and soybean oilmeal are now used primarily for organic fertilizer or livestock food.

With the recent advances in food technology, there now exist the essential ingredients of a new food industry. These are the need for high protein foods, the availability of generous supplies of protein, and the technology to convert the protein supplies into marketable, high protein foods. This industry, currently in its embryonic stage, embraces such food products as Vitasoy -- a high protein beverage in Hong Kong which outsells pop, ProNutro in South Africa, and Incaparina in Latin America. Dozens of additional products are now being developed, with some already in the market testing stage.

In many ways the high protein food industry resembles the low caloric food industry of the United States about a decade ago. In both instances technology evolved to meet a recognized need -- in one case the need for less calories, and in the other for more protein. It is quite possible that we are now on the threshhold of seeing a new industry develop.

Constraints on Agricultural Development

Let me now focus on some of the more serious constraints on agricultural development.

The lack of water is one. There are many countries, particularly in North Africa and the Middle East, where the lack of water seriously

limits the expansion of food production. Water availability may be a principal constraint on food production in India during the 1970's. India's High Yielding Varieties Program is designed to eventually cover 32 million acres. This area, comprising only one-tenth of the total cropland area, nonetheless represents nearly all of the farm land having an assured water supply.

A second brake on agricultural development is the scarcity of foreign exchange. In many of the densely populated, less developed countries, most of the additional capital inputs required to modernize agriculture convert directly into foreign exchange requirements.

A sizable number of the less developed countries do not have within their boundaries any of the basic raw materials used to manufacture chemical fertilizer. These materials include phosphate rock, potash, sulphur, and natural gas, naptha or some other source of hydrocarbons. If agricultural output is to be improved through intensive cultural methods, ever-increasing quantities of fertilizer will be needed. Under these circumstances growing population pressure results in commensurate increases in foreign exchange outlays, a bleak prospect for many less developed countries already facing a heavy debt-servicing load. This problem is well illustrated by the case of India (Figure 10.)

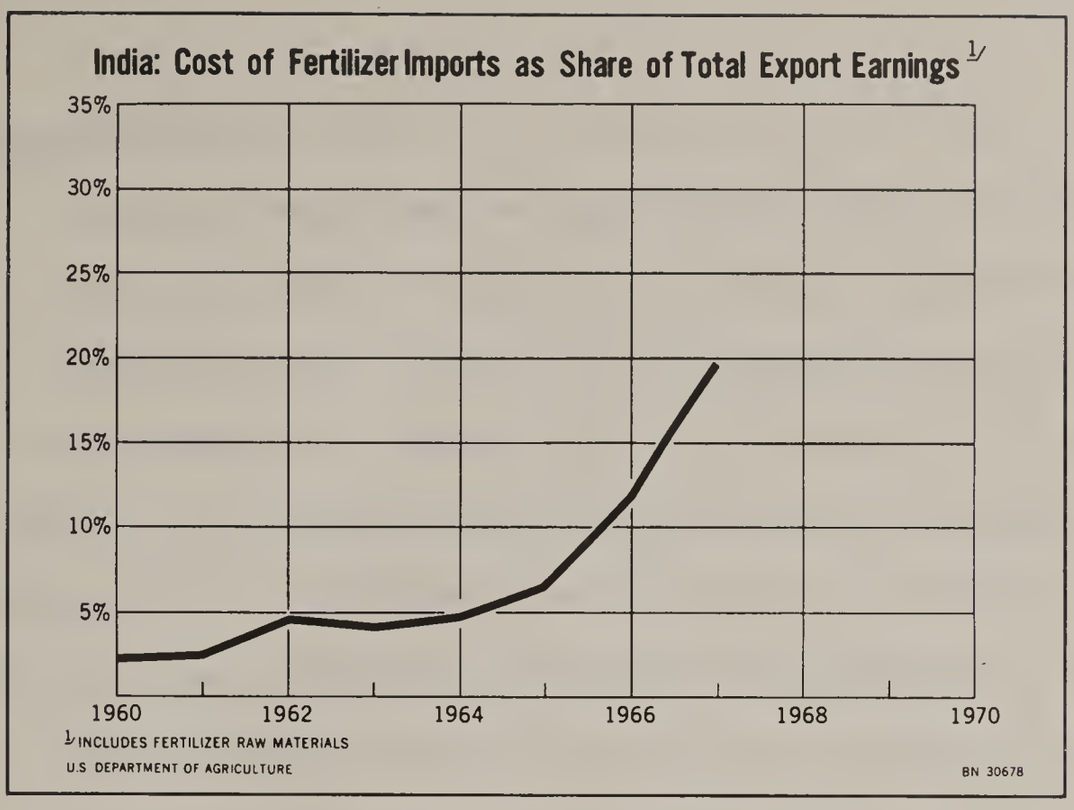


Figure 10

A third constraint is the lack of capital, management, and the technical or marketing know-how needed to produce the inputs and services which underlie a modern, productive agriculture. Of course, the attainment of needed investment levels often requires a revision of domestic policies regulating foreign private investment, an area all too frequently bound to the whims of political expediency.

One of the chief missions of our International Agricultural Development Service is to mobilize the resources of the Department of Agriculture, helping to transfer and adapt the technical know-how, so successfully developed in this country, to the less developed countries. Today we have, in support of the overall development effort administered by the Agency for International Development, some 300 professional USDA agriculturists in Asia, Africa, and Latin America carrying out this

assignment. Their number is growing as the need becomes more acute.

The lack of trained agricultural manpower imposes a more immediate constraint. Education is a luxury in many developing countries, and the percentage of the population which is being educated at advanced technical levels is small. And within this group, the share receiving advanced training in agriculture in some countries is so minute as to be scarcely meaningful. We also assist the developing countries to overcome this deficiency; last year 2000 agriculturists received training in the United States under the auspices of the Foreign Training Division of our International Agricultural Development Service.

A fifth constraint, particularly evident in several Latin American countries, is the inability to implement meaningful land reform programs. Unless those who are tilling the land can be linked more directly with the rewards of increased productivity, the prospects for rapid progress in agriculture are dim.

Finally, it should be noted that the adoption of a new technology is a time consuming and uneven process. In Mexico, for example, high yielding varieties of wheat that are grown mainly by large, commercial farmers have been widely adopted since World War II, with a significant impact on its national yields; on the other hand, hybrid corn -- so successful in the U. S. -- has had relatively little influence since corn is grown chiefly by small, subsistence farmers who are less susceptible to change.

Concluding Remarks

Perhaps the most hopeful single factor which will contribute to an eventual solution of the food problem is the rapidly growing recognition of the problem. That the food problem is one of man's most nearly insoluble problems is now widely accepted.

The policy decisions and resource commitments needed to eliminate malnutrition in the hungry countries are not yet in prospect. There is, however, some perceptible, measurable forward motion along the lines I have outlined here today, much of which will not pay off for some years yet to come.

The food gap between the "have" and "have not" regions cannot be permitted to widen. Sould it do so, the tensions between the two economic areas would be intolerable. Economic and political stability in the developing world are closely linked to an adequate supply of food.

It may be that we have been asking the wrong questions when addressing the food-population problem. Perhaps we should ask not, "How much will it cost to solve the food problem?" but rather, "How much will it cost if we fail to solve the food problem?"

NEW DIRECTIONS IN WORLD AGRICULTURE

The opening weeks of 1968 seem to have been characterized by uncommonly bleak headlines, ranging from the stringent measures announced early in January to improve our international balance of payments to the recent step-up in the conflict in Vietnam. But there is some exceedingly good news elsewhere, and much of it, as usual, is being eclipsed by the bad.

The good news is that we may be on the threshhold of an agricultural revolution in many of the hungry, densely populated countries of the less developed world, particularly in Asia. Further, we are witnessing some advances in food technology which, if commercially feasible, can make quality diets available to millions at much lower costs.

This paper constitutes a more encouraging assessment of food production prospects, in Asia at least, than has previously been possible. Let me identify some of the factors underlying the current assessment, many of them observed during extensive travel in Asia during recent months.

At the top, one senses a new political commitment by Asian governments to respond to the demand by farmers for incentive prices and the range of inputs needed to modernize agriculture. The dramatic new, high yielding varieties of food grains are being disseminated more rapidly among farmers in some countries than had either been planned

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Talk by Lester R. Brown, Administrator, International Agricultural Development Service, U. S. Department of Agriculture, at the Second International Conference on War on Hunger, Washington, D. C., February 20, 1968.

or anticipated. Further, the yield performance of these varieties is proving much more transferable from experimental plots to field growing conditions than was thought possible.

The impact of the new varieties is such that they are becoming an "engine of change," bringing numerous other changes in their wake. They also provide a means for tapping some of the much discussed production potential of tropical agriculture, heretofore largely unexploited.

Despite the progress reported and prospects cited in this paper, the food-population problem is not close to being solved. It is far from solution. But the present dynamic agricultural climate makes Asia today far more receptive to U. S. assistance policies in this field, to agricultural technical assistance programs, and to sound private agribusiness investments than was the Asia of two years ago.

The food-population problem will not be satisfactorily solved until population growth is effectively slowed and eventually stabilized. The agricultural revolution which seems to be in the making will, if it continues, contribute to a solution of the problem by buying additional time for countries to mount effective family planning programs.

Past Record Not Bright

The food production record of the less developed countries from the beginning of this decade through 1966 is not an encouraging one. Food production, scarcely able to keep pace with population growth,

not to mention additional demand generated by rising incomes, fell behind overall demand. The result for country after country was either rising imports, rising food prices or some combination of the two. However, preliminary crop reports for 1967 in the developing countries indicate food output per person gained 6 percent over last year's drought depressed levels, bringing production per person back to the levels of the early 1960's. (See Figure 1.)

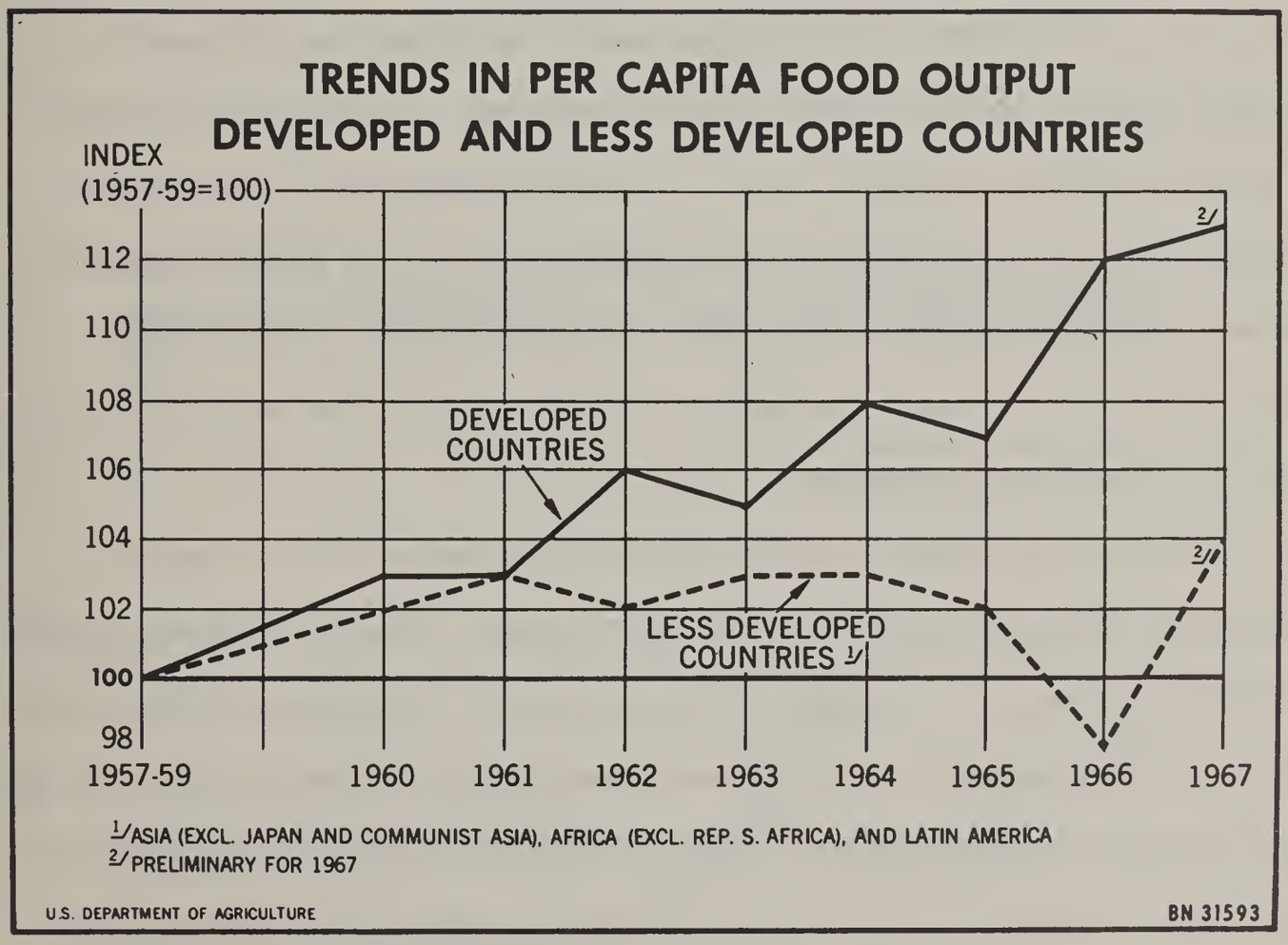

Figure 1

The beginning agricultural revolution is most evident where it is most needed, in Asia, a region containing 56 percent of the world's people. It extends from Turkey to the Philippines, and includes the pivotal countries of India and Pakistan. Together, these four countries alone contain over 700 million people, or about half the population of the less developed world excluding China.

Growing Emphasis on Agriculture

Recent progress traces to several factors including a growing emphasis by governments in these countries on agricultural development, and a willingness to allocate scarce resources to this goal. Several factors underlie this growing emphasis: (1) the disappearance of world surpluses of wheat and rice, (2) the movement toward harder terms on U. S. concessional food shipments, and (3) a growing insistence by our government -- in USDA, AID, and the Congress -- that food aid recipient countries make an adequate effort to develop their own food producing resources.

We have increasingly used food aid as a source of leverage to encourage more rapid growth in LDC food output. When a country requests commodities from us we analyze its agricultural development effort and identify shortcomings. We then seek commitments to remedy them. We may ask a country to build farm-to-market roads, to increase the share of its budget resources going to agriculture, to improve its climate for foreign agribusiness investment or to undertake any of a host of other needed actions. Stated simply, food is no longer a free commodity -- we exchange commodities for commitments, commitments to improve agriculture.

But pressure comes not only from outside. Indeed it seems that the possibilities of the new agriculture have caused farmers to place unprecedented demands on Asian governments to ensure availability of seeds, fertilizer, and other inputs. In fact, the increasing political muscle that farmers have developed may make the commitments of their governments to farmer-oriented policies and programs essentially irreversible, a marked departure from the years of political neglect.

This new political climate -- both international and internal -- has led to concrete commitments of budgetary and foreign exchange resources. India increased its budget for agricultural development by 42 percent last year; it is now using the equivalent of one-fifth of its foreign exchange earnings to import fertilizer and fertilizer raw materials. (See Figure 2.)

Figure 2

Turkey's imports of fertilizer and fertilizer raw material may make up the largest single item in overall imports this year, exceeding for the first time petroleum and petroleum products. The availability of fertilizer in Pakistan is twice that of two years ago, and several times that of 1960. It is expected to at least double again by 1970.

High Prices and New Varieties

Among the major forces for agricultural progress in Asia, two stand out: the sharply higher prices for the major Asian food staples, rice, and wheat, and some dramatically superior new varieties of wheat, rice and coarse grains.

Prices of food grains, particularly rice, have climbed sharply in many Asian countries as a result of scarcity at home and the disappearance of surpluses abroad. This rise, reflected in prices received at the farm level, has made the use of purchased inputs such as fertilizer much more profitable than heretofore. (See Figure 3.)

Exciting new varieties of rice, wheat, grain sorghum, and corn are now available. In large part, they have been developed at the International Rice Institute in the Philippines and at what is now the International Maize and Wheat Improvement Center in Mexico. (The Institute was sponsored by the Rockefeller and Ford Foundations, the Center by Rockefeller). The new varieties are much more responsive to fertilizer than traditional varieties. Under proper growing conditions, they outyield traditional varieties not by a mere 10,

20, or 30 percent but by a multiple of 2 or more. This is why they have caught the imagination of so many Asian farmers.

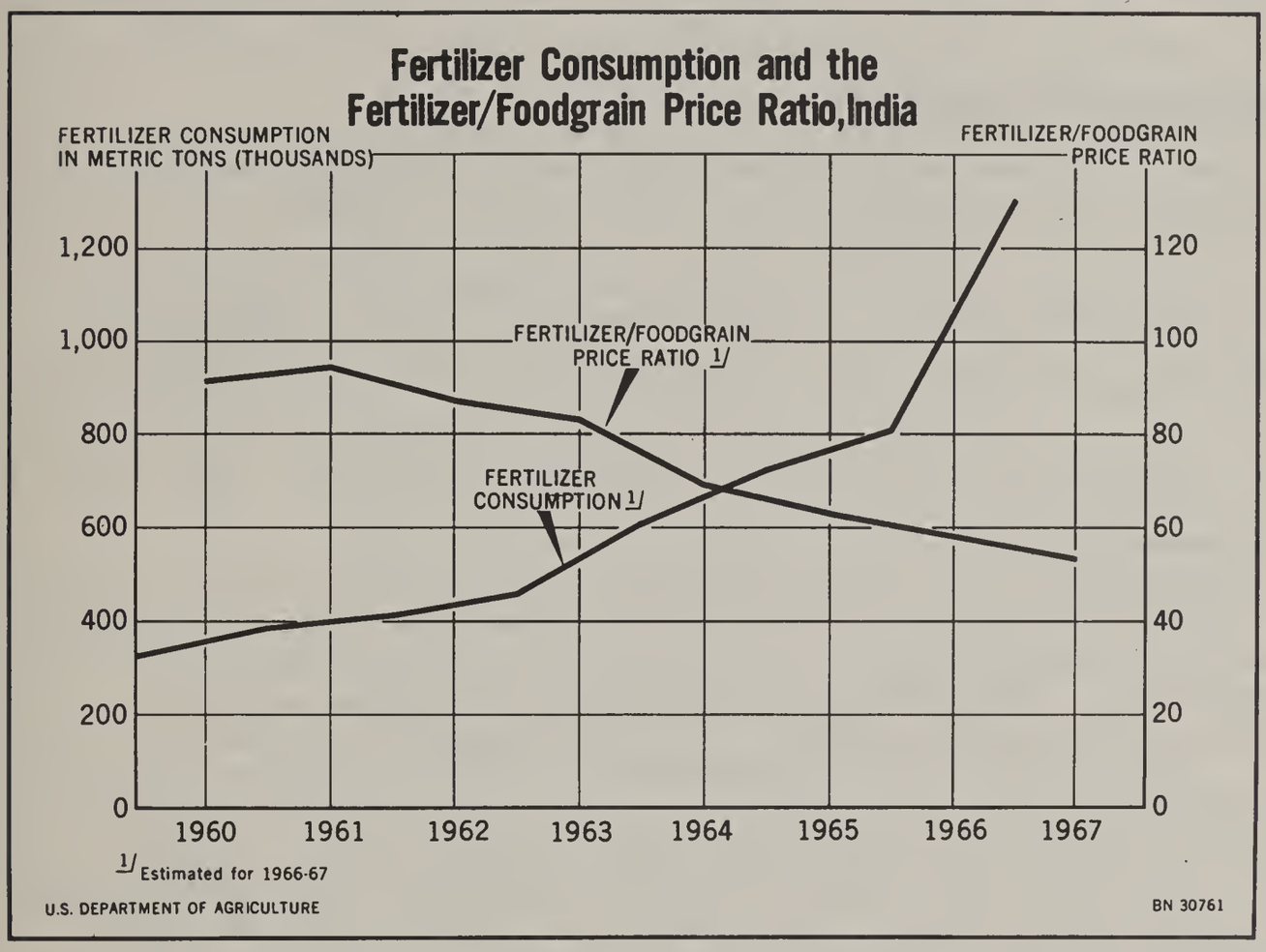

Figure 3

The new rice varieties provide a means for tapping some of the vast but largely unrealized food producing potential of the tropics. At present, rice grown in temperate zone countries, e.g. the United States, Spain, Italy, Japan, and Australia, yields 4,000 - 6,000 pounds per acre (rough rice) as contrasted with only 1,000 - 1,500

pounds in most of the tropical and subtropical rice growing countries. The high yields attainable with the new varieties, coupled with the potential for multiple cropping where water is available, provide some impressive opportunities for expanding the world's food supply.

The Spread of New Varieties

Use of the new varieties, expanding very rapidly in several Asian countries, is already beginning to have an impact on regional grain production levels. The area planted to improved varieties in Asia this year is estimated at 16 million acres -- most of it in India, Pakistan, the Philippines, Afghanistan,and Turkey! The total could expand to 30-35 million acres or more next year.

Improved varieties of wheat and rice have been planted in greatest quantity. India alone has planted about 5 million acres of each. Pakistan has planted approximately 2 million acres of Mexican wheat for harvest this spring, and hopes to plant up to 1 million acres of rice this year. Turkey has nearly 400,000 acres of wheat and the Philippines perhaps 500,000 acres of rice. In addition, nearly 3 million acres of corn and sorghum have been planted in India.

These planting levels are beginning to represent sizable portions of total acreage. The improved varieties of wheat account for about 15 percent of wheat acreage in both India and Pakistan. Proportions for rice are lower -- about 6 percent in both the Philippines and India. Data on the contribution to increased output of the acreage planted to high yielding varieties are not available but

these plantings must have expanded Asia's food grain supply by several million tons.

As improved seed becomes available, the new varieties are often quickly adopted by a relatively small group of farmers -- the larger, more commercial farmers who have adequate irrigation and credit. But the irrigated land suitable to new varieties is limited. And in West Pakistan, for example, lack of farm credit is limiting the distribution of available fertilizer. But these difficulties should not be overestimated since West Pakistan is expected to harvest a wheat crop this spring some 10 percent above the previous record.

The rate of adoption may also be influenced by other factors. Extremely high prices for rice during the past year have stimulated interest in planting improved varieties. As output increases, prices may drop somewhat from present levels -- reducing incentives to plant or to carry out essential cultural practices. The increased output can also lead to problems with inadequate marketing facilities.

Much land is not suited to the new varieties now being disseminated. Some farmers, after trying them, will return to the traditional varieties. But the overall trend will be up. And in the short run, food shortages can be alleviated or self-sufficiency obtained with only a portion of total acreage planted to improved varieties. Over the longer run, strong and continuing research and breeding programs will be necessary to insure steady progress.

New Varieties - Engine of Change

The new food grain varieties are far more than just another technological breakthrough -- they may be to the agricultural revolution in Asia what the steam engine was to the industrial revolution in Europe. In addition to their influence on production, the new varieties are playing a critical role as a catalyst, causing farmers to break with tradition and reconsider their agricultural practices.

It was hoped earlier that fertilizer would perform this function, and it has, to some extent. But traditional varieties are often not responsive enough to fertilizer to provide the readily visible profit peasants need to adopt new practices.

Some of the new varieties -- like IR-8 developed at the International Rice Institute -- do well even with traditional cultivation methods. But far more than the old rice, IR-8 is responsive to scientific farm management, to far heavier doses of fertilizer, to timely pesticide treatment, to a broad range of improved practices. Not only do farmers learn through experience that the so-called "miracle rice" works; they learn that it works better if accompanied by generally improved production technology.

The new varieties are requiring a reexamination of existing agricultural policies and development strategies. The more intensive use of labor associated with the new varieties for instance -- the new high yielding rice varieties require weeding -- is actually result-

ing in seasonal labor shortages in some rural locales in Asia. Wages paid farm laborers in India's Punjab during the harvest season reportedly exceeded those paid skilled laborers in New Delhi this year. As a result of labor scarcities during planting and harvest seasons in some areas, planting and harvesting are being staggered and extended over a longer period. Crop calendars are being revised.

The new rices grow both during the monsoon and during the dry season, provided, of course, enough water is available. Many traditional varieties, because they are much more photoperiod sensitive and require a longer growing season, are not as adapted to growth during the dry or winter season. Dissemination of the new varieties is thus often followed by a sharp rise in the index of multiple cropping.

Alterations in cropping patterns are also occurring. Farmers with enough water to grow a crop of rice during the dry season will frequently do so. Those with insufficient water for rice are turning to a cereal with lower water requirements, usually grain sorghum. This is now occurring in the Philippines and India. After the first cutting, grain sorghum sometimes ratoons (regrowth from original root stock) one or two times providing additional harvests of grain from the original planting. Test fields of rice and sorghum multicropping at the International Rice Institute in the Philippines have reportedly yielded 8 tons of grain per acre per year! This contrasts with an average of 2 tons of corn per acre in the United States.

Accelerating Farm Mechanization

Among the traditional assumptions concerning agricultural development, those concerning farm mechanization are perhaps most in need of reexamination. Experience with the new rice varieties is demonstrating this need.

IR-8 matures in 120 - 125 days, as contrasted with 150 - 155 days for traditional varieties. When planted at the customary time at the beginning of the monsoon, it matures well before the end of the monsoon. Once ripe, it must be harvested quickly, and artificially dried lest it sprout in storage. Traditional rices, maturing after the monsoon, can be harvested in a more leisurely manner and dried in the sun along the roadside. The new varieties then may require, as a minimum, mechanical drying. In many instances, mechanical threshing may also be advisable.

Because IR-8, and most other high yielding rice varieties are quick maturing, it is often possible to plant a second crop of rice before the end of the monsoon. If planted promptly, such a crop can use monsoon rainfall for initial growth, then supplemental irrigation thereafter. But such rapid seedbed preparation may not be possible with bullocks and bullock drawn equipment. Mechanical power may be required. Similarly, under some conditions tractors must be used for seedbed preparation to realize the full potential of Mexican wheats.

The full potential of the high yielding rices cannot be realized in the absence of careful water management. This requires pumps,

engines, and fuel to both move water out of the paddy, when natural rainfall or flooding is excessive, and to move water in, particularly during the dry season when additional water is needed.

Projections Out of Date?

As the "agricultural revolution" spreads throughout Asia it is becoming increasingly difficult to project rates and directions of change. Many of the numerous studies undertaken in recent years, projecting the production and demand of food and the demand for purchased farm inputs, have not allowed for the possibility of sharply increased yields due to new technology.

Increased yields may make it possible to halt the trend toward growing food deficits and in some cases reverse it. The Philippines expects to be self-sufficient in rice in a year or so; Turkey may be self-sufficient in wheat shortly thereafter. Pakistan and India are moving rapidly to narrow the gap between food consumption and food production. Other nations, not yet doing as well, are also showing signs of forward progress.

Existing projections for fertilizer demand may require alteration in light of the greater responsiveness of the new varieties to fertilizer. Some projections of fertilizer demand have assumed that the use of one additional pound of fertilizer would yield 10 pounds of additional grain. Available information shows the new varieties have a much higher response coefficient.

In the short run, the greater responsiveness of the new varieties should increase the profitability of fertilizer use and increase the demand for fertilizer above what it would otherwise have been. Over the longer run, however, the demand for fertilizer could be lower than would otherwise have been the case since a smaller quantity of fertilizer will be required to achieve any given level of food grain production. Nonetheless, the developing countries face a continuing fertilizer deficit, requiring increased imports unless the pace of their new plant construction accelerates within the next few years.

The growing demand for irrigation pumps, engines, and tubewells will accelerate in the future as the need for supplemental irrigation and better water management increases. Heavier investment in inputs for a given crop -- needed to realize the genetic potential of the new varieties -- requires better protection from insects and diseases. A new market for mechanical rice drying equipment is also developing far ahead of the supply.

If I were a Vice President for International Operations of an American agribusiness firm, I would have some of my staff out in the wheat fields and rice paddies of Asia attempting to assess the marketing and investment implications of the new, high yielding varieties of grain. The demand for virtually all inputs will be affected.

Advances in Food Technology -- Closing the Protein Gap

The remarkable advances in production technology discussed previously should not obscure the recent breakthroughs in food tech-

nology which, though not as yet nearly as far along, may in the long run augment the current production advances. At the same time as increased yields are making available greater quantities of food, food technologists and private industry are improving food quality through the development and better utilization of low-cost sources of protein.

The problem posed by the shortage of protein in the LDC's is in many ways parallel to the excess calorie problem in the United States. Confronted with the need to reduce the caloric content of diets, food technologists began developing low calorie foods and beverages. A technology evolved to meet a need, creating a low calorie food industry which today manufactures and markets more than 700 million dollars worth of low calorie food products in the United States.

In the problem of protein shortage, there are similar elements -- a widespread need and a technology evolving in response to this need. There are now indications that a high protein food industry is emerging to parallel the low calorie food industry.

The conventional means of eliminating deficits of high quality protein has always been to expand production of livestock products. (See Figure 4.) As per capita incomes rise over a long period of time, protein deficiencies in diets disappear, but only at a high cost in terms of grain required. Given the costliness of eliminating protein deficits using livestock, U. S. food firms are increasingly attracted to the possibility of developing livestock product substitutes from vegetable sources.

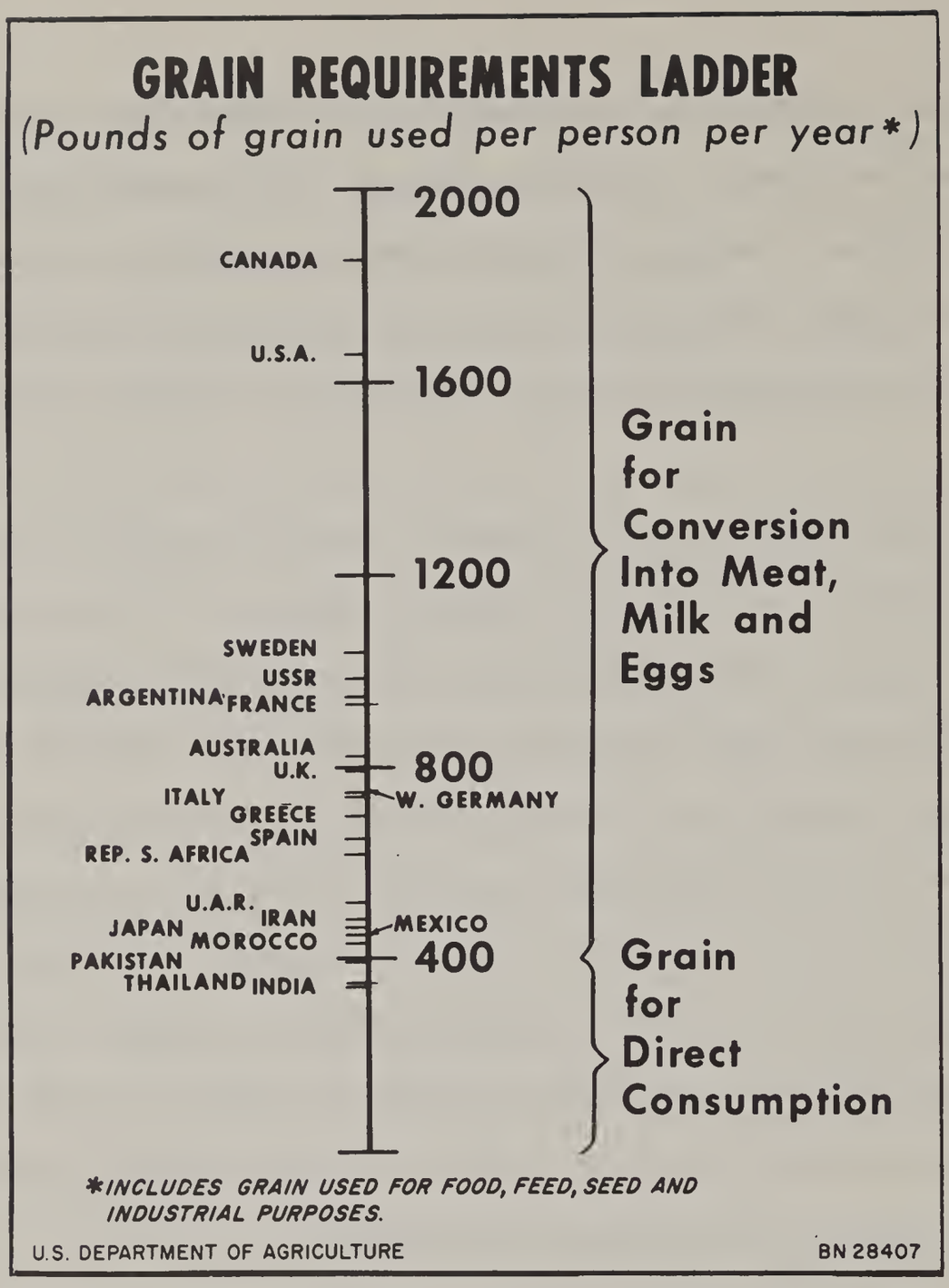

Figure 4

Substitute livestock products have developed gradually over the past generation, with the pace accelerating in recent years. The average American now consumes more margarine than butter. Hydrogenated vegetable shortenings have largely replaced lard in our diet.

To date, substitution has been primarily vegetable oils for animal fats, but food firms are now pushing ahead rapidly to develop protein products such as substitutes for milk and meat. Researchers in laboratories of several major U. S. food firms are confident of developing products synthesized from soybeans or other vegetable protein sources which will be virtually indistinguishable from chicken, ham, and beef. One major U. S. food firm is already test marketing a substitute for bacon.

Most hungry countries have indigenous supplies of high quality protein -- usually in the form of soybean oil meal, cottonseed oil meal, peanut oil meal, or copra -- which can be used to manufacture high protein foods. These oilmeals are often used for a variety of purposes, including fertilizer, livestock feed, and as export commodities. But some food firms are beginning to incorporate these proteins into imitation or substitute livestock products, beverages, gruels, and breakfast foods, to be marketed commercially. AID is supporting several market surveys and market testing projects by U. S. firms in developing countries.

Recent advances in synthesizing amino acids now make it economically feasible to upgrade cereal protein by adding small quantities of the limiting amino acids. The addition of a few pounds of lysine, costing about 4 dollars, to a ton of wheat raises the quality of wheat protein to a level approaching that of casein, the protein in milk.

With U. S. encouragement, the Indian Government bakeries in Madras and Bombay last month began marketing a lysine-fortified product called Modern Bread. Early reports indicate that it has been selling out every day, and plans are underway to extend lysine-fortification to several other Government bakeries, with private bakeries also expressing strong interest.

At present, the use of synthetic amino acids to fortify food is one of the most exciting possibilities available for making substantial inroads against malnutrition. Unlike most other methods of upgrading protein intake, this does not require changes in dietary habits. Over the longer run, it may be possible to achieve the same end by evolving new varieties of cereals which will contain a larger percentage of higher quality protein.

Conclusions

Exceedingly favorable prices for food grains in most Asian countries, coupled with some dramatic new technologies in the form of high yielding varieties of rice, wheat, and coarse grains, are triggering an "agricultural revolution" in Asia. The superiority of these varieties over traditional ones is so pronounced that they are becoming an "engine of change" in rural areas; they are altering cultural practices, the level and pattern of inputs used, cropping patterns, and the index of multiple cropping.

Many factors will constrain the rate at which the new varieties are disseminated -- inadequate water supplies, a shortage of farm

credit, and susceptibility of some of the new high yielding varieties to local insects and diseases. But it seems quite likely that food production in free Asia will, barring unforeseen circumstances, expand much more rapidly over the next few years than it has thus far during the 1960's.

Accompanying the revolution in agricultural technology are some exciting advances in food technology such as the utilization of oilseed meals in high protein foods and the fortification of cereals with synthetic amino acids. These breakthroughs could contribute measurably to alleviating the widespread shortage of protein in the hungry countries over the next 5 - 10 years.

But while the potential for improving the world food situation may be in hand, the benefits thus far have been limited. To strengthen the favorable forces now at work and see the revolution through will require continued commitment by governments in the developing countries, supported by all the assistance the United States can provide.

The new varieties were referred to earlier as an engine of change. We could carry the analogy a bit further and say that we now have the engine going; but an engine at full steam needs far more fuel and attention than one sitting at a switching station waiting to get a track.

Years of U. S. assistance, both public and private, coupled with stepped up efforts by the developing countries themselves, are beginning to pay off. It is essential that we work to maintain and

accelerate the forward momentum now developing. If maintained, this momentum greatly enhances the near-term prospects for putting Asian agriculture on a more modern footing -- for turning the current advances into a pattern of self-sustaining agricultural growth.

A NEW ERA IN WORLD AGRICULTURE

By Lester R. Brown
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The organizers of the annual Senator Frank Carlson Symposium on World Population and Food Supply are to be commended for their initiative in selecting this means of honoring one of the outstanding citizens of Kansas and of the United States. It is a privilege to appear as leadoff speaker at this, the first annual symposium, featuring so many outstanding authorities on the world food problem, including Senator George McGovern of South Dakota and two prominent Kansans, Under Secretary of Agriculture John Schnittker and Senator-elect Robert Dole.

The thesis of this paper is that the world has recently entered a new agricultural era. It is difficult to date precisely this new era since many of the contributing factors have been years in the making. But in terms of measurable phenomena such as the sudden sweeping advances in food production in several major developing countries, the old era ended in 1966 and the new began in 1967.

During the earlier era, spanning the two decades from the end of World War II through 1966, the less developed world was characterized by (1) accelerating population growth, (2) a sharp reduction in the

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USDA 3773-68

area of new land that could be readily brought under cultivation, (3) lagging food production, failing to match population growth in some instances, and (4) increasing dependence on food aid from the United States. During the 1950's food production in the developing countries increased largely as a result of expansion in the cultivated area; but as it became more difficult to bring new land under the plow during the early 1960's, the growth in production slowed perceptibly.

The new era is characterized by explosive increases in production of principal crops in the larger developing countries of Asia. The 1968 Pakistan wheat harvest was up 37 percent over the previous record, possibly an increase without precedent in any major country. India's wheat crop this year was up 35 percent over the previous record; its total food grain harvest up 12 percent. Ceylon's rice crop has increased 34 percent during the past two years. The Philippines, with two consecutive dramatic gains in its rice crop, has apparently ended half a century of dependence on rice imports.

Favorable weather has contributed to the record harvests in some countries, such as India, but it is only one factor; these countries are now achieving takeoffs in yield per acre comparable to those achieved in the developed countries during the first half of this century. Increases in per acre wheat yields in Pakistan and India and of rice yields in the Philippines over the past two years may exceed those of the preceding several decades.

Thus far the most rapid advances have been concentrated in Asia, a region containing more than half the world's people. But countries

elsewhere -- Mexico in Latin America and Kenya and the Ivory Coast in Africa -- are also enjoying the fruits of modern agricultural technology. Within the next several years the agricultural revolution will likely spread to most of the less developed world.

The new era is dynamic, providing new opportunities for farm families, promising to bring into the marketplace literally hundreds of millions who heretofore have eked out a subsistence living, consuming all that they produce. This will broaden the market within individual developing countries, greatly enhancing the prospect for industrial development.

I. Setting the Stage for Agricultural Development

Several closely interrelated factors contributed to the growing emphasis on agricultural development during the mid-1960's, which has led to the new agricultural era. Among these are (1) the reduction in surplus grain stocks in the exporting countries, principally the United States, (2) two consecutive monsoon failures on the Indian subcontinent, affecting the food supply of 625 million people, (3) rising prices of major food grains, especially rice, both within the major developing countries and in the world grain market, (4) a consequent fear by political leaders of possible food shortages and political instability that might result, and (5) several basic changes in U.S. foreign agricultural and foreign assistance policies during the mid-sixties.

A "short tether" policy for food aid was adopted in the summer of 1965. Multi-year food aid agreements such as the 4-year, 17 million

ton food grain agreement signed with India in 1960 became a thing of the past. From mid-1965 forward, the duration of agreements with major countries was measured in months rather than years, with further agreements contingent upon efforts to "get agriculture moving."

The United States sharply increased its support for agricultural development; AID funds for agriculture rose from less than $200 million in the early 1960's to $520 million in 1968. Also indicative of the rising concern over the race between food and people was an increase in the AID budget for family planning from $2.1 million dollars in 1965 to $50 million this year.

In late 1963 David Bell, then Administrator of AID, and Secretary Freeman concluded an agreement calling for the use of USDA resources to support AID's agricultural efforts overseas. This resulted in the creation within USDA of the International Agricultural Development Service, the agency I now head, and enables us to draw upon USDA's 29,000 professional agriculturists for both long term resident assignments and for short term consultancies. Since 1963 USDA has sent 975 agricultural advisors to 54 countries, some for short term assignments of a few weeks, others for up to four years.

Partly in response to the developments mentioned above, several developing countries substantially increased the resources going into agricultural development. Imports of fertilizer into Turkey this year may exceed those of petroleum, traditionally the leading commodity import. Two years ago India expanded its agricultural budget by more than a third. The availability of fertilizer in Pakistan has increased

severalfold thus far during the 1960's and may double again by 1970. The Government of the Philippines has given unprecedented support to a crash rice production program. Political leaders began to identify with and to support accelerated food production programs.

These increased commitments to agricultural development are both a cause and a characteristic of the new era in world agriculture.

II. Engines of Change

The pronounced improvements in the economic and political climate for agricultural development and the massive introduction of the high-yielding varieties are dramatically improving the prospects for expanding food production in the developing countries. The new varieties may be to the agricultural revolution in the less developed world what the steam engine was to the industrial revolution in Europe.

Thus, the agricultural revolution now underway in the developing regions, principally Asia, is much more than just the conventional formula of using improved seeds, fertilizers, pesticides and more water. This is another characteristic of the new era. The new cereal varieties are not just marginally better than traditional ones; they are dramatically superior, frequently doubling yields, under field conditions. Their superiority is indicated by the rate of expansion in their use:

Estimated Acreage in New High-Yielding Varieties in Asia 1/

Year	Acres
1964/65	200
1965/66	37,000
1966/67	4,800,000
1967/68	20,000,000
1968/69	34,000,000

The new dimensions of the agricultural revolution now underway and the numerous sources of increased food production deriving from it make it difficult to comprehend. Some sources of potential increases in production are:

(1) Greater fertilizer responsiveness; the new varieties not only respond to much heavier applications of fertilizer but they use it more efficiently. If one pound of nitrogen fertilizer applied to the old varieties resulted in 10 pounds of additional grain production; a pound applied to the new varieties may result in 15 or, as has been recorded under very favorable circumstances, as much as 25 pounds of grain.

(2) The new varieties are aseasonal; unlike most of the traditional varieties they are not very sensitive to day length. They can, therefore, be planted at any time of the year in most of the tropics and sub-tropics where water supply permits.

(3) The new varieties are early maturing; in the case of rice, 120 days as contrasted with 150 to 180 days.

1/ Dana G. Dalrymple, "Estimated Area of High-Yielding Varieties of Grains in Ten Asian Nations," International Agricultural Development Service, U. S. Department of Agriculture, November 1968. The 1968/69 figure represents goals.

(4) Multiple cropping is increasing; both the possibility of planting year round and earlier maturity permit an increase in double or triple cropping. Farmers in India, Indonesia and the Philippines are now double cropping rice and, in some instances, even triple cropping where water supplies are adequate. Where water supplies are not adequate during the dry season, farmers are beginning to plant high-yielding grain sorghums. Sorghum, after harvest, will again tiller in the tropics, permitting a second and often a third harvest from the one initial planting. Farmers in Mysore State in India are producing three crops of corn every 14 months. In parts of Northern India and West Pakistan, rice is being grown during the summer monsoon season with wheat as the winter crop. Some farmers are able to plant a third crop such as potatoes or a protein crop like beans.

(5) Mechanization is increasing food production; new technologies require a re-examination of the feasibility of farm mechanization in densely populated, developing countries. Full use of the new technologies requires much greater inputs of labor in more careful planting, continuous weeding, frequent irrigation and the harvesting of much larger crops. Seasonal labor shortages in rural areas of Asia are becoming increasingly common. Farm mechanization will permit better seedbed preparation, enabling farmers to more fully realize the full genetic potential of new varieties. The possibility of continuous cropping throughout the year places a real premium on both rapid harvesting and seedbed preparation. My deputy, Dr. Lyle Schertz, describes this as follows:

> ... with the high-yielding varieties that can be grown year round, each day of delay means 1 day of lost crop production. With 120-day rice capable of yielding 2 tons per acre, almost 40 pounds of paddy (rough rice) per acre per day are at stake. 2/

(6) The use of water, like fertilizer and other inputs, is rising steadily; the prospect of growing the new varieties throughout the year means that the value of water has increased sharply, particularly during the dry season. Farmers throughout Asia are investing heavily in tubewells and pumps to lift water into their fields, either from underground sources or from low flowing rivers and canals during the dry season.

The potential increases in food production associated with the new varieties are only a partial listing, but they illustrate the dynamic nature of the new technologies.

III. The U. S. Role

The agricultural revolution in the developing countries is strongly supported by the United States. Both public and private U. S. interests have combined to help launch what may be the most successful U. S. involvement overseas since the Marshall Plan.

The U.S. involvement in Asia, where the farm revolution is most advanced, is quite varied. Since 1960, AID, USDA and land grant universities have together trained some 4,000 Asian agriculturists in a wide range of agricultural and related fields.

AID investments over the past 15 years, in such activities as the construction of irrigation facilities and farm-to-market roads and

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2/ Lyle P. Schertz, "The Role of Farm Mechanization in the Developing Countries," Foreign Agriculture, November 25, 1968, p. 3.

the building of agricultural institutions have created the agricultural infrastructure needed to support the widespread advances now occurring. Land grant universities have helped develop competent counterpart institutions in several developing countries. USDA/AID advisors have helped formulate agricultural price policies needed to provide farmers with incentive prices, making the use of modern technology profitable.

U.S. agribusiness firms are supplying a large proportion of the agricultural inputs -- fertilizer, pesticides, irrigation equipment and farm implements needed to generate and sustain this revolution in the countryside. An estimated two-thirds of all the fertilizer plants being built in Asia outside Japan and Mainland China are being built by U.S. firms, either on their own or in collaboration with local firms.

The exciting new technologies at the heart of the farm revolution -- the high-yielding varieties of rice, wheat, corn and grain sorghum -- have been developed largely by the Ford and Rockefeller Foundations.

Having identified these U.S. contributions, let me leave no illusions as to who is primarily responsible for the exciting advances of the past few years. These are due largely to the efforts of the countries themselves.

IV. Second Generation Problems

When agriculture begins to advance rapidly, as it is now doing in several developing countries, many new or second generation problems

are created. Often these are problems of success. Such is the case in a number of countries where rapid increases in grain production are overloading the existing, antiquated marketing systems.

In some areas where farmers traditionally marketed one-third of their crop, their crop increased by one-third, as a result of adopting new production technologies. This means the marketable surplus has suddenly doubled. Few marketing systems are equipped to handle abrupt increases of this size. Over the past 15 years many of the larger coastal cities in Asia have become increasingly dependent on imported foodstuffs with their populations at times living quite literally from "ship to mouth." As countries begin to generate surpluses in the rural interiors, a distribution system must be developed which will permit movement of such surpluses to the large coastal cities. 3/

Another second generation problem, quickly coming into focus in several countries is the lack of farm credit. During the early stages of innovation and adoption of new production practices, the larger farmers -- usually well situated financially -- are characteristically the first to use new inputs. Once use of a new inputs such as fertilizer begins to expand beyond the larger farmers, then the need for credit becomes acute. Without it some small farmers are, in effect, denied access to the new technologies.

A third problem beginning to plague a number of countries as grain production surges ahead is declining prices. Many countries have

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3/ For a more extended discussion of marketing problems, see Martin Kriesberg, "Marketing Food in Developing Nations - Second Phase of the War on Hunger," Journal of Marketing, October 1968, pp. 55-60.

instituted price support programs for wheat and rice during the last few years while market prices have been relatively high. As market prices now begin to drop to the support level, many governments are hard pressed to maintain the price guarantees given farmers. As production expands, countries must also wrestle with such questions as, What is a desirable price level? and, How should the internal support level relate to world market prices?

The new varieties, frequently less acceptable to consumer tastes than the familiar indigenous varieties, are often discounted in the marketplace. Over time, the discount usually diminishes as consumer tastes adjust to the new varieties or breeding efforts alter them to suit local preferences.

As new agricultural technologies are adopted, their benefits are not distributed evenly. Those farmers with the more fertile soils and the more reliable year round water supplies stand to benefit most. The economic gap between the better farms and farmers and the more marginal ones is almost certain to widen in the developing countries as it seems to have in the United States over the past half century.

This is not a definitive listing of second generation problems facing developing countries, but it does illustrate some of the more pressing ones.

V. The Renaissance in Agricultural Research

Agricultural research, an area of heavy investment within the United States over the past half century, but until quite recently

largely neglected by both the international assistance agencies and the governments of the developing countries, is now being given some of the attention it deserves. The success of the Rockefeller Foundation's wheat breeding program in Mexico dating back to the 1940's and the lack of attention to rice in Asia led the Rockefeller and Ford Foundations to combine resources to establish the International Rice Research Institute in the Philippines in 1962. The relatively quick and dramatic payoffs in rice breeding, following the success with wheat, have awakened widespread interest in agricultural research in the developing countries.

Today, the work in Mexico is being carried out under the Rockefeller and Ford-sponsored International Maize and Wheat Improvement Center (CIMMYT) at Chapingo. Two additional centers are being organized by the two Foundations: the International Center for Tropical Agriculture (CIAT) in Palmira, Colombia, and the International Institute for Tropical Agriculture (IITA) in Ibadan, Nigeria. Rather than concentrate on particular crops, these latter two centers will work on tropical agriculture more broadly.

The return to society from investment in the established centers has been phenomenal. The cost of establishing and funding the International Rice Research Institute has totaled some $15 million to date. The value of additional rice production resulting from the spread of new rice varieties and improved cultural practices is already in the hundreds of millions of dollars. Within the next several years it could total several billion dollars!

The accomplishments of these foundation-sponsored research efforts are historic. But perhaps their most significant long term contribution will be the support they engender, and the encouragement they provide, for agricultural research in the developing countries.

Indigenous research establishments in several Asian countries have already released some exciting new varieties of cereals. Those now in use include: BPI-76 in the Philippines; H-4 in Ceylon, ADT-27 in India; and MexiPak-type wheats being released in Pakistan.

The plant breeders at the International Rice Research Institute, who developed the IR-8 miracle rice, expect that even it will be obsolete within a few years, replaced by still more efficient varieties. The Uttar Pradesh Agricultural University in India reports that Mexican-type wheats introduced only three years ago will soon become obsolete due to the development of even better varieties (Sonalika, Sona, and Chhoti Lerma). Breeding work on triple gene wheats is also very promising.

Within the past few years an informal network has developed between AID, USDA, the foundations and the agricultural universities for the exchange of germ plasm and information on research results. An effort is being made by my own agency to disseminate information in other areas, including analyses and reports of our short-term consultants, who deal with many of the problems which arise almost daily throughout the developing countries as the new technologies are applied for the first time.

Within the next few years, we can expect agricultural research to gain further impetus as the large multinational agribusiness concerns that manufacture fertilizer, pesticides and farm equipment, distribute seeds and process and market farm products, begin to invest in their own agricultural research. Such firms finance and conduct more than half of all agricultural research in the United States today.

VI. Future Production Prospects

Are the recent agricultural advances a temporary phenomenon, or a new trend? They appear to be the latter. The agricultural revolution seems to have gone too far now to be arrested. Too much is at stake, too much has been invested, the expectations of too many people have been aroused. The agricultural revolution in Asia should not, therefore, be viewed as an event but as the beginning of a process -- the eventual modernization of Asia.

Sources of potential food production increases in the future are, as indicated earlier, quite numerous. Prominent among these will be the steadily growing acreage planted to the ever more efficient crop varieties. This expanding acreage of fertilizer responsive varieties, combined with the prospective reduction in cost of nitrogen fertilizer, will broaden the profitable opportunities for fertilizer use.

Cultural practices will improve as farmers re-examine traditional practices and experiment with new ones. The development of multiple cropping as a science will greatly increase the potential food production capacity.

The production revolution, now confined largely to major cereal crops, will spread to other crops such as root crops, pulses and oilseeds. A major AID/USDA research effort designed to develop higher yielding varieties of pulses (lentils, chickpeas, etc.), and improved cultural practices are already promising some impressive breakthroughs. As this project moves ahead in both Iran and India, the prospects for raising critically low protein intake levels are improving steadily.

Opportunities exist for vast improvements in water storage and management and control facilities, particularly at local levels. Indicative of efforts to exploit these opportunities is the AID/USDA effort now underway in three states in India containing 127 million people. The trend in Asia will be toward more emphasis on intensifying production on the better land, already under cultivation, and relatively less on large-scale capital intensive reclamation projects.

Rapid production increases in a given crop are much more readily obtained as long as a country is deficit in that crop. Unless a country has a strong comparative advantage and ready access to world markets, the rate of production increases will slow down once self-sufficiency is attained. After that, production gains are likely to be a function of growth in the internal market.

The principal benefits of modern, and continually advancing, agricultural technology have yet to be realized in the developing countries. Wrong decisions can, however, slow the rate of progress. If the Indian Government, for example, fails to confront the problem of a large and growing internal deficit in fertilizer, Indian agricultural prospects

will be reduced. If the U.S. Congress fails to understand the significance of the agricultural breakthroughs of the past few years, and their potential for bringing about gains to the United States, and if in consequence it fails to provide the necessary support to sustain the developments now underway, the pace of advancement could be slowed.

VII. Economic Growth and U. S. Farm Exports

We should not overlook the role of the agricultural revolution in developing viable economies in the less developed world or the significance of this, in turn, for U.S. farm exports. It is difficult to give away farm products to people living at the subsistence level, much less sell them anything. Only as they enter the marketplace and develop some purchasing power can they be expected to buy our products. As Dorothy Jacobson, Assistant Secretary of Agriculture for International Affairs, once put it:

> That market is a sleeping giant, with an almost endless capacity to consume. But this sleeping giant will awaken, and this market come to life, only when economic growth brings higher incomes and greater buying power. 4/

Few, if any, countries can supply from indigenous production the wide variety of agricultural products their people will demand as their incomes rise. Not even the United States, with one of the most productive and diversified farm economies in the world, comes close to satisfying the demands of its people. U.S. agricultural imports, exceeding $4 billion yearly, include commodities such as coffee, bananas, tea, rubber and copra which are not produced here at all.

4/ Dorothy H. Jacobson, "The Future of U.S. Agricultural Exports to Developing Countries," speech delivered at Upper Midwest Forum on Agricultural Export Trade, Minneapolis, Minnesota, May 18, 1966.

The countries with outstanding agricultural performances in recent years -- Japan, Taiwan, Israel and more recently Mexico, South Korea and Pakistan -- have, with the exception of Mexico, tripled their purchases of U.S. farm products over the past 8 years.

Value of U.S. Commercial Agricultural Exports 5/

Country	Average 1956-60	1966	1967
	(million dollars)		
Japan	335	900	863
South Korea	10	20	42
Taiwan	4	30	68
Pakistan	5	9	13
Israel	10	44	38
Mexico	69	79	70

U.S. farm exports for dollars have climbed 80 percent over the past decade, largely because of the rising levels of prosperity in scores of countries around the world. Any really massive future expansion of U.S. dollar farm exports is dependent on the modernization of the developing economies, bringing their subsistence-oriented populations into the world market economy.

VIII. Protein and the Quality of Life

Protein malnutrition is a severe debilitating force in the tropics and sub-tropics, affecting hundreds of millions of people, particularly infants and growing children whose protein requirements are relatively higher than for adults. This deficiency exacts a heavy human toll in terms of suffering and a heavy economic toll in terms of underdeveloped and wasted human resources.

5/ Source: Agricultural Statistics, 1967, p. 714; U.S. Foreign Agricultural Trade by Countries, Calendar Year 1967, October 1968, pp. 1-3.

Protein malnutrition costs in several ways: it prevents people from reaching full physical development and, even more disturbing, full mental development. Stated simply, a youngster deprived of protein during the first few years of life cannot fully develop his inherited capacity for learning and for thinking.

To date, very little attention has been given to nutrition as a component of development strategy. And yet economic growth can be meaningful only in terms of developing human resources. Strategy designed to develop people as fully as possible has several components: education, nutrition, health and family planning, among others. Several advanced countries have full employment policies designed to utilize their labor forces as fully as possible. Why shouldn't a country have an adequate nutrition policy to ensure that its people have the opportunity of developing to their full inherent potential?

Dr. Eugene Campbell, with the AID Mission in Brazil, has pointed out that the economic returns on people born into a society vary widely depending on how effectively these people are developed as a resource. Taking a million people at birth in three separate locations -- Northeastern Brazil, the Sao Paulo area, and the United States -- Campbell points out that, after adjusting for life expectancy and literacy:

-- the million people born into Northeastern Brazil contribute only 12 million adult-literate man years to society,

-- those born into the Sao Paulo area 25 million,

-- and those in the United States 48 million;

a four-fold variation between the lowest and the highest.

This does not of course take into account the differences in quality and productivity of adult-literate man years contributed, which may be even greater than the variation in man years.

Alan Berg, head of the Food and Nutrition Division in our AID Mission in India, recently cited a dramatic example of a widening gap in the development of athletes. India, a country with 535 million people, failed to qualify a single track and field athlete to go to Mexico City. Not one athlete could meet the minimum qualifying standard set by the International Olympic Committee. This was a matter of training techniques, and interest among other things, but nutrition was undoubtedly a factor. 6/

IX. Increasing Protein Intake

As the role of nutrition in human development becomes clearer, the interest in expanding protein supplies rises. Several independent and widely varying efforts are now underway to expand the quantity and quality of protein available for human consumption in the developing countries.

One of these is the effort to improve the protein content of cereals through plant breeding. The discovery of high lysine corn at Purdue was one of the first breakthroughs. Corn varieties containing this gene have a protein quality far superior to conventional varieties. Within the next year or so, high protein corn varieties are to be released in the United States, Colombia and Kenya.

6/ Alan D. Berg, "On Food and Music," remarks at the Indian Association of Food Technologists, New Delhi, India, September 23, 1968.

Geneticists at the International Rice Research Institute are now giving increased attention to protein content of rice. Of the several hundred varieties tested thus far, protein content has ranged from 7 to 14 percent. The average for rice varieties now grown in Asia is probably about 8 percent. If high-yielding varieties could be developed that would raise this to, say, 10 percent, this alone would greatly increase the protein intake among Asia's predominantly rice consuming population.

Another promising effort to increase the amount of protein consumed centers around the use of oilseed proteins for human consumption. Dr. Aaron Altschul, my colleague in the International Agricultural Development Service, who is providing worldwide leadership in this exciting effort, states the case very well.

> Oilseeds alone could furnish 25 million tons of protein, as much as man presently secures from animals. If protein intake per person were increased as little as five grams per day (four pounds per year) a substantial majority of the malnourished children and adults would no longer suffer protein deficiency.
>
> Fortunately, oilseeds are strategically located in areas of need. In many countries, where meat, milk, and eggs are scarce and beyond most peoples' means, high-protein oilseed crops exist in great quantity. The world's largest coconut producers are the Philippines, Indonesia, India, and Ceylon. Among the world's larger cottonseed producers are Egypt and Chad. Egypt produces a million tons and Chad 56,000 tons per year. Today, these cottonseeds may be used for fertilizer or animal feed. But now an improved process is being tested to make edible cottonseed protein concentrate.
>
> Peanuts are another largely unused protein source. Several African and Asian countries have large peanut crops. If a portion of these crops were devoted to peanut flour, very

> rich in protein, malnutrition would be reduced. India's peanut crop alone could satisfy the whole Indian population's daily protein needs.
>
> Soybeans can become a familiar crop in more countries as adaptive research is applied to this high-protein crop. Since soy contains close to forty percent protein, it has already become a favorite ingredient of various new protein foods. 7/

With today's technology these proteins can be converted into very appealing, nutritious foods. Several firms are market testing such high-protein foods. Included in this new group of foods are Vita-soy, a soy-based beverage which claims 20 - 25 percent of the soft drink market in Hong Kong where it is manufactured. Monsanto has developed a high-protein beverage it plans to produce and market in protein deficit countries. Coca-Cola is test marketing a soya based, chocolate flavored beverage, designed to be the nutritional equivalent of milk, in a suburb of Rio de Janeiro.

Several firms, including Swift, Pillsbury, Monsanto, Del Monte, Dorr-Oliver, Archer-Daniels Midland, International Milling, Krause Milling and General Mills, have received AID market survey grants to test market protein foods in several countries, including El Salvador, Brazil, Thailand, India, Tunisia, Kenya and Pakistan.

There is an interesting parallel between the development of high-protein foods and an earlier situation in the United States. Beginning a decade or so ago many Americans began to realize they were consuming far too many calories for their health. The need to consume fewer

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7/ Aaron Altschul, "Using Unused Protein Supplies," International Agricultural Development Newsletter, February 1968, p. 15. For further details on the work led by Altschul, see: "Combatting Malnutrition: New Strategies Through Food Science," IADS, May 1968, 29 pp.; "Food Science Narrows the Edibility Gap," The New York Times, November 25, 1968, p. 46.

calories began to express itself in the marketplace, as a technology for producing low-calorie foods evolved. The result was the creation of a low-calorie food industry, now doing more than $750 million worth of business per year.

In the developing countries the need is not for less calories but for more protein. A technology is beginning to evolve and meet this need in the marketplace. The result, in my opinion, will be the development of a high-protein food industry in the developing countries, in many ways paralleling the low-calorie food industry in the United States.

Another new technology which may figure prominently in the solution of the protein problem is the low cost synthesis of amino acids, the building blocks of protein. This makes it possible to fortify lower quality proteins such as in cereals, substantially upgrading their quality at very low cost.

The addition of four pounds of lysine -- costing $1 per pound -- to a ton of wheat raises the quality of protein to one approaching that of casein, the dominant protein in milk. Bread sold in government-operated bakeries in several major Indian cities is now fortified not only with vitamins and minerals but with lysine as well. In nutritional terms this bread is truly a "staff of life."

X. What We Have Learned

Over the past few years we have learned a great deal about agricultural development. Perhaps more importantly we have learned to adapt and apply a great deal we already knew.

We have long known, for instance, that farmers would use modern technology only if it were profitable to do so. This was the foundation for building American agriculture. We are now beginning to apply this knowledge in the less developed countries as well. Secretary Freeman has often said,

> I have met many farmers who could not read or write but never one who could not count.

The performance of farmers in the most remote areas of Asia, Africa and Latin America is demonstrating that farmers do indeed respond to profit.

We can approach any given developing country today with confidence, knowing that we can put together a combination of agricultural policies and agricultural technologies which will "get agriculture moving" -- assuming, of course, a genuine interest on the part of the recipient country. Without this interest, generating an agricultural takeoff is difficult, if not impossible.

We have learned within the past few years that it is much better to concentrate assistance efforts than to spread these efforts over a wide range of crops and activities. The prospect of a successful assistance effort increases severalfold when we select a single crop. often the food staple, such as wheat in Turkey or rice in the Philippines, and then concentrate resources -- research, credit, administrative capability, information services, etc. -- behind the effort to greatly expand production of that crop.

We failed to recognize in the earlier years of our assistance programs that an important constraint on development programs was the

shortage of administrative capability within the government of the recipient country. It is also much easier to obtain the personal interest and support of a President or Prime Minister for a single program dealing with a leading crop than for several dozen fragmented development projects scattered throughout the economy.

Another advantage of concentrating on a single crop with specific and often ambitious targets is that progress becomes quite measurable. This has a positive psychological effect on those working on the program. With specific targets, those working on the project can both derive satisfaction from their accomplishments and analyze and correct shortcomings. Concentration also helps gain support, within both donor and recipient countries, for aid programs.

We have also learned that food aid can be more than just a means of disposing of surpluses or filling hungry stomachs. It represents $1.5 billion of leverage to bring about much-needed policy changes and agricultural reforms in recipient countries. Now we exchange commodities for commitments by governments to take specific steps to improve agriculture in the recipient countries, such as providing incentive prices to farmers, building farm-to-market roads, eliminating the import tax on agricultural inputs, or any of scores of other actions required to eliminate bottlenecks. This approach has been encouraged by the President, Secretary Freeman, and particularly the Congress which strongly emphasized it in the Food for Freedom Act of 1966. It has been a major factor in bringing about much-needed agricultural reforms.

Another lesson we have learned is that a successful U.S. assistance effort requires involvement of the entire U.S. agricultural community including USDA, the foundations, the agribusiness corporations and the land grant universities.

Recognition by AID, USDA and businessmen that the U.S. agribusiness community must be even more involved than at present, has led to the recent formation of the Agribusiness Council. Consisting of some 50 of the largest international agribusiness firms in this country, the Council, headquartered in New York, is headed by George Mehren, until a few months ago Assistant Secretary of Agriculture.

We have learned that a modest investment of our resources can often bring about far-reaching changes affecting millions and sometimes hundreds of millions of people. It is a source of great satisfaction within my agency to be able to mobilize professional competence within the Department, bringing it to bear on problems confronted by aid-recipient countries. The problems vary widely, ranging from an outbreak of bean diseases in El Salvador, a resurgence of the desert locust in East Africa, to a crash effort to devise methods of drying the new, early maturing rices harvested during the Asian monsoon.

XI. Significance of Agricultural Breakthroughs

The agricultural revolution, already underway in countries containing more than half the population of the less developed world, excluding China, has significance far beyond its more immediate effect

on the food supply. For literally hundreds of millions it is the key to the door opening into the twentieth century.

If the agricultural revolution continues to spread, encompassing most of Africa and Latin America as it now does Asia, then the entire world may be exposed to and affected by progress. Should this happen it will be the first time in history that virtually all of mankind, including the one and a half billion rural people of the less developed world, will be able to move ahead together.

The recent agricultural breakthroughs achieved by several developing countries should sharply accelerate their rates of economic growth. Not only are the rapidly growing farm sectors directly contributing much more to the overall rate of economic growth, but they are also, because of sharp increases in purchasing power in rural areas, stimulating a much more rapid rate of growth in the non-farm sector of the economy.

Successful use of the new high-yielding varieties requires farmers to use a whole new range of cultural practices, a package of new inputs. The new varieties are thus serving as engines of change, forcing farmers to break with centuries of tradition. Once rural populations break with the past in this key area, they become much more susceptible to change in other areas such as education and family planning, and more interested in progress generally.

The agricultural revolution now underway -- for which the United States can take at least partial credit -- may represent the most impressive U.S. achievement abroad since the rebuilding of Europe under

the Marshall Plan following World War II. Measured in terms of people affected, the agricultural revolution is far more important than the rebuilding of Western Europe, which affected only a small share of the world's people.

Perhaps the most significant aspect of the farm revolution is the psychological effect it may have on government leaders in the developing countries. If modern technology should enable the developing countries to solve their food problem -- a problem many considered nearly insoluble -- then it may give government leaders confidence in the ability of modern technology to solve some of their other difficult problems.

Although the emphasis in this paper has been on the agricultural breakthroughs rather than on the bottlenecks, I do not intend to imply that the food problem is close to being solved. It is not. Moreover, the new and technologically complex era in agriculture will increase -- not decrease -- the need for technical assistance from the agriculturally advanced countries.

Thus far during the 1960's the population problem has been equated with the food-population problem. This may not always be. By 1980 the population problem will more likely be referred to as the employment-population problem. People begin requiring food at birth; jobs are not required for another 15 or 20 years. It is this prospect of large and almost certainly growing numbers of unemployed in the less developed countries that poses the principal threat to political stability over the next decade or so.

The current agricultural breakthroughs, however, will buy time with which to slow population growth and to achieve some technological breakthroughs in contraceptive technology. This is imperative. For in the long run our ability to influence the population variable will determine our success in solving the food problem, the employment problem, and many of the other pressing problems we face during the remaining one-third of this century.

The new era in world agriculture is a dynamic one, promising much to many. Old problems are being replaced by new challenges. We must continue to recognize these challenges and respond to them.